DOCUMENT RESUME

ED 480 388 CE 085 380

AUTHOR	Kershaw, Isaac; Mazak, Sara A.; Spence, Janet G.
TITLE	Environmental/Natural Resources Technologies. State Competency Profile.
INSTITUTION	Ohio State Univ., Columbus. Tech Prep Curriculum Services.
SPONS AGENCY	Ohio Board of Regents, Columbus.; Ohio State Dept. of Education, Columbus.
PUB DATE	2000-00-00
NOTE	407p.
AVAILABLE FROM	For full text: http://www.ohtpcs.org/cp/environmental.asp.
PUB TYPE	Guides - Non-Classroom (055)
EDRS PRICE	EDRS Price MF01/PC17 Plus Postage.
DESCRIPTORS	Academic Standards; Administration; Basic Skills; College School Cooperation; *Competency Based Education; Data Processing; Education Work Relationship; *Employment Qualifications; *Environmental Education; Job Skills; *Natural Resources; Outcome Based Education; Pollution; Postsecondary Education; Secondary Education; State Standards; Statistical Analysis; *Tech Prep; *Technical Occupations; Wastes
IDENTIFIERS	Geographic Information Systems; *Ohio

ABSTRACT

This document, which lists the environmental and natural resources technology competencies identified by representatives from businesses and industries as well as secondary and postsecondary educators throughout Ohio, is intended to assist individuals and organizations in developing college tech prep programs that will prepare students from secondary through postsecondary associate degree programs for employment in these eight occupational clusters: pollution prevention and control, environmental sampling and analysis, health and safety, environmental compliance assurance, hazardous materials handling, water environment management, fishery and wildlife habitat management, and geographic information management systems. The competencies, which are separated into essential competencies needed to ensure a minimal level of employability and recommended competencies, are organized by instructional units and include suggestions as to when students should be introduced to, reinforced, and proficient at them. The Tech Prep Competency Profile(TCP) matrix includes a list of 39 technical competencies that are essential or recommended for employment in the occupational clusters listed above. Some of the common competencies are as follows: technical documentation; statistical analysis; management and supervision; environmental science; environmental assessment; soil science; hydrology; chemical technology; equipment operation and maintenance; surveying and mapping; waste management; hazardous materials management; database administration; and communication. The document includes a profile review of panel participants and occupational area definitions. (MO)

Reproductions supplied by EDRS are the best that can be made from the original document.

ED 480 388

TECH PREP

ENVIRONMENTAL/NATURAL RESOURCES TECHNOLOGIES

State Competency Profile

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL HAS
BEEN GRANTED BY

M. Aring

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

1

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)
☑ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

Tech Prep Curriculum Services
In conjunction with
The Ohio Department of Education
And
The Ohio Board of Regents

CE085350

BEST COPY AVAILABLE

INTRODUCTION

The Ohio Environmental/Natural Resources Technology Competency Profile was developed under the auspices of the Joint Council of the Ohio Board of Regents and the State Board of Education. It provides the framework for a broad-based educational response to Ohio's need for a skilled Environmental/Natural Resources workforce.

The profile includes a comprehensive set of Environmental/Natural Resources competencies that are grounded in core academic subject areas and built around eight occupational clusters: Pollution Prevention and Control, Environmental Sampling and Analysis, Health and Safety, Environmental Compliance Assurance, Hazardous Materials Handling, Water Environment Management, Fishery and Wildlife Habitat Management, and Geographic Information Management Systems. Generated using the Ohio Tech Prep model of curriculum development, the profile reflects the job opportunities and skills required for Ohio's Environmental/Natural Resources technology workers.

Ohio business/industry representatives and educators worked together to create the Environmental/Natural Resources Technology Competency Profile. Representatives from a broad cross-section of Ohio businesses and industries played a critical role in this effort. Business/industry representatives defined the vision and scope of Environmental/Natural Resources technology. They also identified the essential and recommended skills for current and future Environmental/Natural Resources technology professionals. Secondary and post-secondary educators representing schools and colleges throughout Ohio identified when in the educational process and to what depth those skills identified by business should be addressed.

The Ohio Environmental/Natural Resources Technology Profile will be used as the basis for the development of an integrated delivery system that provides opportunities for new and challenging Environmental/Natural Resources technology programs and courses in Ohio's secondary schools, colleges, and universities. Career-Technical Education, Tech Prep, and adult education will be enhanced and expanded through the use of the Environmental/Natural Resources Profile.

This profile is available on the Internet at: www.ohtpcs.org. At this location, users can download copies of the entire profile or conduct searches on a number of key variables. Additional information on academic connections and certification crosswalks is available at this site.

For additional information contact:

Tech Prep Curriculum Services
The Ohio State University
1900 Kenny Road
Columbus, Ohio 43210
(614) 247-7426
spence.16@osu.edu

ACKNOWLEDGEMENTS

The Ohio Environmental/Natural Resources Technology Competency Profile is a project of the Joint Council of the Ohio Board of Regents and the State Board of Education. In addition to the business/industry representatives and educators listed on the following pages, a number of individuals contributed their time and expertise to this initiative. Special thanks is due to Jonathan L. Tafel, Associate Vice-Chancellor, Ohio Board of Regents; Joanna Kister, Director, Career-Technical and Adult Education, Ohio Department of Education; Julie Novel, Supervisor, Tech Prep, Career-Technical and Adult Education, Ohio Department of Education; and Richard Arndt, Director, K-16 Initiatives, Ohio Board of Regents. Their vision, support, and encouragement made this project possible.

Thanks are also due to the following:

Project Managers:
Isaac Kershaw, Assistant Director, Career-Technical and Adult Education, Environmental and Agricultural Education, Ohio Department of Education
Sara A. Mazak, Senior Program Associate, Tech Prep Curriculum Services, The Ohio State University
Janet G. Spence, Senior Program Associate, Tech Prep Curriculum Services, The Ohio State University

Draft Document Development and Panel Facilitation:
Linda Fauber, Consultant, Tech Prep Curriculum Services

Panel Facilitation:
Beverly Smith, Tech Prep Coordinator, Edison State Community College
John Miley, Supervisor, Career-Technical and Adult Education, Environmental and Agricultural Education, Ohio Department of Education
William Waidelich, Vocational Education Consultant, The Ohio State University

Research and Editorial Assistance:
Steven D. Chambers, Librarian, Tech Prep Curriculum Services, The Ohio State University

Information Services:
Christopher Dickman, Systems Specialist, Tech Prep Curriculum Services, The Ohio State University
Gregory D. Lyle, Systems Specialist, Tech Prep Curriculum Services, The Ohio State University

Administrative Support:
Janet I. Ray, Administrative Assistant, Tech Prep Curriculum Services, The Ohio State University

TABLE OF CONTENTS

Profile Review Panel Participants iii

Occupational Area Definitions xiii

Key to Profile Codes xvii

Ohio Environmental/Natural Resources Technology Competency Profile Matrix xix

Environmental/Natural Resources Technology Competency Profile Units, Competencies, and Competency Builders 1-408

ENVIRONMENTAL/NATURAL RESOURCES TECHNOLOGY CURRICULUM DEVELOPMENT PROFILE REVIEW PANELS

FUTURING PANEL

March 3, 2000

Purpose: To define the vision and scope of Environmental/Natural Resources and identify critical occupational areas

Participants:

Laurie Chase, I/I Program Manager (Engineer)
City of Columbus

D. Gary Cox, Assistant Attorney General
Environmental Enforcement Section

Mark Glasgow, Assistant Attorney General
Environmental Enforcement Section

John Hollback, Environmental Affairs Manager
American Electric Power

Tom Jenkins, Senior Hydrogeologist
Burgess and Niple, Ltd.

Lewis Jones, Dairy Division Chief
Ohio Department of Agriculture

Ron Kolbash, Deputy Director, Resource Conservation
Ohio Department of Natural Resources

David Landis, Research/Director of Educational Programming, Division of Recycling
Ohio Department of Natural Resources

Joseph F Lorenz, CEO
Pro-Terra Environmental Contracting Company

John Marks, Professor, Environmental Resource Management, Parks Recreation and Wildlife
Muskingum Area Technical College

Timothy J Murphy, Manager, Training Services
Environmental Resource Training Center, The University of Findlay

Mike Parkes, Communication and Employee Relations Manager
Von Roll WTI

John Sadzewicz, Manager, Division for the Water/Waste Water
R. D. Zande and Associates, Inc.

Lee Schoen, Vice President
Floyd Browne Associates

Mark Shanahan, Executive Director
Air Quality Development Authority

Jeff Steers, Assistant Chief of Northwest District Office
Ohio Environmental Protection Agency

Larry Vance, Chief of Division of Soil and Water Conservation
Ohio Department of Natural Resources

Jerry Wager, Administrator of Pollution Abatement and Land Treatment Section
Ohio Department of Natural Resources

Tony Wisbith, Principle Research Scientist
Battelle Memorial Institute

Barb Wooldridge, Environmental Specialist
Ohio Environmental Protection Agency

Steve Wordelman, Partner
Jones and Henry Engineering

BUSINESS AND INDUSTRY REVIEW PANEL

March 30, 2000

Purpose: To identify essential and recommended skills for Environmental/Natural Resources professionals

Participants:

Daniel Adams, Senior Geologist/Vice President
Foppy Technical Group

Mohammad I. Alam, Director
Cincinnati Health Department

John Bates, Wastewater Superintendent
Village of Caldwell

Joe Carvitti, Manager, Ohio Operations
TRC Environmental Corporation

Chris Clark, Utilities Director
City of Sidney

Duane R. Day, Environmental Manager
Bayer Corporation

Jeannette T. Durkalski, Chemist, Natural Resources
OARDC/Ohio State University

Ed Folk, Woodberry Wildlife Management
Retired

Tami Galliher, Research Assistant
OARDC/Ohio State University

Melissa Griffith, Stillwater Forester
Ohio Department of Natural Resources, Division of Forestry/MWCD

Bryon L. Holbrook, HES Technician
Marathon Ashland Petroleum LLC

Charles Kane, Supervisor, Treatment
Metropolitan Sewer District of Greater Cincinnati, Hamilton County

John Kirwin, Air Pollution Control, Central District
Ohio Environmental Protection Agency

Fred Klingelhaver, Unit Supervisor, Air Pollution Control
Ohio Environmental Protection Agency, Southeast District Office

Ronald Kolbash, Deputy Director, Resource Conservation
Ohio Department of Natural Resources

Kent E. Kroonemeyer, Supervisor, Ecological Services
U.S. Fish & Wildlife Service

David Landis, Researcher
Ohio Department of Natural Resources

Lola Lewis, Regional Urban Forester
Ohio Department of Natural Resources, Division of Forestry

Paul Logsdon, Environmental Health & Safety Manager
Clark Lima Refinery

Kenneth Maly, Crime Analyst, GIS Technician
Akron Police Department

Noah McManus, Health & Safety Coordinator/Project Coordinator
Rader Environmental Services, Inc.

Walter Olszewski, Environment Manager, Foil Division
Gould Electronics

Aaron Otto, Law Enforcement Planner
Akron Police Department

Cathy Pickrel, Toxicologist
Ashland, Inc.

John Rauch, Technical Assistance Provider
Great Lakes RCAP

Gordon Rudloff, Agriculture Inspection Manager
Ohio Department of Agriculture

John Sadzewicz, Division Manager, Water/Waste Water
R. D. Zande and Associates, Inc.

Nicholas A. Scambilis, Chair Environmental Engineering Technology
Sinclair Community College

Lee Schoon, Vice President
Floyd Browne Associates, Inc.

Jeff Steers, Assistant District Chief
Ohio Environmental Protection Agency, Northwest District Office

Robert A. Stonerock, Investigator
Ohio Department of Natural Resources, Division of Oil & Gas

Andy Tippel, Naturalist
Blue Rock-Muskingum River State Parks

Leslie M Van Kuren, Environmental Chemist
Quanterra, Inc.

Jeffery J. Wander, Environmental Specialist III, Site Investigation
Field Unit
Ohio Environmental Protection Agency

Carolyn Watkins, Chief, Office of Environmental Education
Ohio Environmental Protection Agency

EDUCATOR REVIEW PANEL

April 20, 2000

Purpose: To identify when and to what depth essential and recommended skills should be addressed in the educational process

Participants:

David Apsley, Forestry
Hocking College

Richard Bennett, Assistant Professor
The University of Akron

Gary Bergstrand, College Instructor
Hocking College

Joe Beringer, Environmental Tech Instructors
Miamisburg High School

Greg Bush, Environmental Tech Instructors
Miamisburg High School

Joe R. Cahill, Instructor
Hocking College

William S. Carter, Associate Professor of Environmental Management
University of Findlay

Jeff Cramer, Dept Head/Assoc Prof, Science
Stark State College of Technology

Bob Daniels, Agricultural Education Teacher
West Muskingum High School

Diane D. DeYonker, Natural Resource Teacher
Natural Science Technology Center

Diane Dudzinski, Professor of Biology
Washington State Community College

Daniel Durfee, Professor
Muskingum Area Technical College

Michael D. Erbaugh, Environmental Management Instructor
Greene County Career Center

Robert Erwin, Environmental Management Instructor
Centerville City Schools

Susan Everett, Associate Professor, Agribusiness/Horticulture
Clark State Community College

David Gardner, Chairman
Owens Community College

William Garnett, Professor of Biology
Raymond Walters College

Louise M. Gerl, Science Teacher
Western Hills High School

David Landis, Researcher
Ohio Department of Natural Resources

Daniel Leininger, Instructor
Hocking College

Jim Lorz, Instructor
Laurel Oaks Career Development Campus

John R. Marks, Professor, Environmental Resource Management/Parks Recreation & Wildlife
Muskingum Area Technical College

Julie Maurer, Administrator
Columbus State Community College

David Miller, Instructor
Clark State Community College

John Oliver, Natural Resources Teacher
Marlington High School

William Peneston, Wildlife Biologist/Professor
Hocking College

Robert Scott Placier, Instructor
Hocking College

Susan Roseum, Tech Prep Science Instructor
Auburn Career Center

David A. Sagan, Instructor
Hocking College

Nick Scambilis, Chair, Environmental Engineering Technology Department
Sinclair Community College

Tom Steckel, Professor of Chemistry
Washington State Community College

Dana R. White, Ag Science/Natural Resources Teacher
Miller High School

Ruth Willey, Dept Head/Teacher
Fremont Ross High School

Rebecca J. Wood, Instructor
Hocking Technical College

Tom L. Zimmerman, Associate Professor
The Ohio State University ATI

Jennifer Zylko, Instructor, Environmental Technology
Stark State College of Technology

STAKEHOLDER REVIEW PANEL

November 15, 2000

Purpose: To refine the Ohio Environmental/Natural Resources State Competency Profile through dialogue among all key stakeholders

Business & Industry Participants:

Mohammad I Alam, Environmental Director
Cincinnati Health Department

John Bates, Wastewater Superintendent
Village of Caldwell

Jeannette T Durkalski, Chemist, Natural Resources
OARDC/Ohio State University

Bryon L Holbrook, HES Technician
Marathon Ashland Petroleum LLC

Charles Kane, Treatment Supervisor
Metropolitan Sewer District of Greater Cincinnati, Hamilton County

Fred Klingelhaver, Unit Supervisor, Air Pollution Control
Ohio Environmental Protection Agency, Southeast District Office

Walter Olszewski, Environment Manager, Foil Division
Gould Electronics

Cathy Pickrel, Project Manager, Toxicologist
Ashland, Inc.

John Rauch, Southern District Manager
Great Lakes Rural Community Assistance Programs (RCAP)

John Sadzewicz, Division Manager, Water/Waste Water
R. D. Zande and Associates, Inc.

Lee Schoon, Vice President
Floyd Browne Associates, Inc.

Jeff Steers, Assistant District Chief
Ohio Environmental Protection Agency, Northwest District Office

Robert A Stonerock, Investigator
Ohio Department of Natural Resources, Division of Mineral Resource Management

Carolyn Watkins, Chief, Office of Environmental Education
Ohio Environmental Protection Agency

Educator Participants:

Richard Bennett, Assistant Professor
The University of Akron

Joe Beringer, Environmental Technology Instructors
Miamisburg High School

William S Carter, Associate Professor, Environmental Management
University of Findlay

Robert Daniels, Agricultural Education Instructor
West Muskingum High School

Karen Dearbaugh, Director, Support Services
Eastland Career Center

Diane D DeYonker, Natural Resource Teacher
Natural Science Technology Center

Diane Dudzinski, Professor of Biology
Washington State Community College

Daniel Durfee, Professor
Muskingum Area Technical College

David Gardner, Chairman, Industrial Operations
Owens Community College

William Garnett, Professor of Biology
Raymond Walters College, University of Cincinnati

Louise M Gerl, Science Teacher
Western Hills High School

John R Marks, Professor, Environmental Resource Management/
Parks, Recreation, & Wildlife
Muskingum Area Technical College

Julie Maurer, Administrator
Columbus State Community College

David W Miller, Assistant Professor
Clark State Community College

Nick Scambilis, Chair, Environmental Engineering Technology
Sinclair Community College

Bill Somerlot, Teacher
Eastland/New Albany School

Tom Steckel, Chemistry Professor
Washington State Community College

Dana R White, Ag Science/Natural Resources Teacher
Miller High School

Tom L Zimmerman, Associate Professor
The Ohio State University/ATI

ENVIRONMENTAL OCCUPATIONAL AREA DEFINITIONS

Pollution Prevention and Control - Individuals employed in pollution control ensure the prevention of pollution and safe and effective collection, treatment, disposal and documentation of agricultural and industrial by-products, air emissions, waste, hazardous waste, water treatment and waste water products in compliance with local, state and federal regulations. Skill areas should include, but are not limited to:

compliance with laws, regulations, policies and contracts
safe working conditions
data recording and analysis
preparation of summaries and charts for review
creative solutions for preventing pollution and reducing the use of toxic materials
extent, sources, and clean-up of pollution
certification for various positions
quality control practices
operation, calibration, and maintenance of equipment and pollution control devices
data and sample collection
operation and calibration of field and laboratory instruments
watershed pollution prevention and control

Environmental Sampling and Analysis - Individuals employed in environmental instrumentation and monitoring determine presence, sources, intensity and constituents or components in air, water, soil and waste through field and laboratory techniques utilizing principles of agriculture, chemistry, meteorology, engineering and applied technologies in accordance with government regulations and methodologies. Skill areas should include, but are not limited to:

safe working conditions
installation, operation and calibration of field and laboratory equipment and instruments
data recording and analysis
basic chemical, physical, and biological analyses
hazards recognition
flow monitoring
bio-monitoring
process monitoring
sampling and tracking

Health and Safety - Individuals employed in health and safety evaluate and minimize the risk to human health in relationship to the industrial/commercial/municipal workplace, hazardous and infectious waste sites, air pollution, water supply, and sanitation processes. Skill areas should include, but are not limited to:

safety training programs
job hazard analyses
workplace hazards
Materials Safety Data Sheets (MSDS)
corrective action plans
cost and cost benefit statements for specific corrective actions
accident incidence statistics/accident investigation
certification for various positions
OSHA Workplace Standards 29CFR 1910.120

Environmental Compliance Assurance - Individuals employed in environmental compliance assurance ensure that environmental permits are complied with or assistance is provided to ensure compliance. They may also assist in developing standard operating procedures. Skill areas should include, but are not limited to:

safe working conditions
complaint response
stress response
violations identification and reporting
citations and warnings
compliance inspections
risk assessments
application, modification, or termination of permits
implications of the regulatory development process
certification for various positions
training program assistance

Hazardous Materials Handling - Individuals employed in hazardous materials handle, process, sample and store hazardous materials and respond to hazardous materials situations in accordance with regulatory requirements. Skill areas should include, but are not limited to (*Under Revision*):

collection, preparation, documentation, and shipping of samples for analysis
sample data analysis
equipment related to hazardous materials operations
hazardous materials identification and labeling
calibration, operation, and maintenance of required instrumentation
documentation of hazardous materials management activities
hazardous materials handling, transporting, and storing in accordance with regulations
hazardous materials treatment and disposal systems
toxic effects of hazardous materials on people
certification for various positions (e.g., HAZWOPER)
construction techniques and equipment
mechanical skills

Water Environment Management - Individuals employed in water resource management help solve fresh water resource related problems via conservation agencies and environmental businesses and industries. Skill areas should include, but are not limited to:

water resource utilization
water pollution control and design
water conservation
wetlands management
watershed protection and planning
data collection and analysis
compliance with laws, regulations, policies and contracts
extent, sources and clean-up of water pollution
point and non-point source pollutants
contamination pathways
water ecology
basic toxicology
biological/chemical and ecological effects
test result analysis
drinking water treatment control and design
drinking water treatment equipment
wastewater treatment equipment
basic economics and finance
human health issues

Fishery and Wildlife Habitat Management - Individuals employed in fishery and wildlife habitat management maintain or manage natural resources, including soil, water, plants, animals and fish for recreational purposes and the best interests of the environment. Skill areas should include, but are not limited to:

hatchery fish propagation
fish and wildlife disease control
data compilation
wildlife conservation
wildlife habitats
migratory and native species of birds, mammals, fish, endangered species, and other wildlife
federal, state, and local regulations
wetlands management
animal damage control
human-animal conflicts
bio-monitoring
stream, lake, and pond management

Geographic Information Management Systems - Individuals employed in cartography/Geographic Information Systems (GIS) compile, refine, and map data on selected environmental, economic, natural, infrastructure, and cultural resources for a variety of uses such as habitat rehabilitation, wildlife tracking, resource management, floodplain management, phase mapping, trending analysis, benchmarking, and water quality. Skill areas should include, but are not limited to:

computer skills
digital maps
data collection
database management
database and Geographic Information Systems integration
GIS analysis including GPS/remote sensing concepts, map projections, scale, resolution, accuracy and precision
statistical theory/analysis
resource management principles
surveying

Possible GIS Specialty Areas

Waste Management
Fishery and Wildlife Management
Watershed Management
Soil Science
Forest Science
Environmental Recreational Planning
City and Community Planning
Ecosystem Management
Marine/Oceanography Studies

* *

KEY TO PROFILE CODES

* *

GRADE LEVEL

12 = by the end of grade 12

AD = by the end of the Associate Degree

DEPTH

I = **Introduce** (applies to 25% of the competency builders. In competencies with 3 or less builders, all builders should be introduced before this code can be used.)

R = **Reinforce** or add depth (after introducing or proficiency)

P = **Proficient** (achievement of the competency **without** supervision)

OTHER (Determined by Business, Industry and Labor Panel)

Essential Competency: Competency is needed to ensure **minimal** level of employability. Entry level employees should be able to perform this competency without supervision at the end of the associate degree. Competencies required for certification, licensure, and/or national skills standards should be tagged as essential.

Recommended Competency: Competency should be included but is not essential for minimal level of employability.

Delete: Competency should not be included.

Example:

BIL: Essential – PC, ECA, HS
Recommended - FWM

EDU:	12	AD
PC	P	I
ESA		
HS		P
ECA	P	R
HM		
WEM		
FWM	I	P
GIS		

Competency1.1: Analyze . . . .
Competency Builders:
Explain . . . .
Identify . . .

ENVIRONMENTAL/NATURAL RESOURCES TECHNOLOGIES
TECH PREP COMPETENCY PROFILE

Matrix

PC = Pollution Prevention and Control
ESA = Environmental Sampling and Analysis
HS = Health and Safety
ECA = Environmental Compliance Assurance
HM = Hazardous Materials Handling
WEM = Water Environment Management
FWM = Fishery and Wildlife Habitat Management
GIS = Geographic Information Management System

Page #	Unit #	Unit	PC	ESA	HS	ECA	HM	WEM	FWM	GIS
1	1	Technical Documentation	E	E	E	E	E	E	E	E
5	2	Statistical Analysis	E	E	E	E	E			E
15	3	Management & Supervision	E	E	E	E	E	E	E	R
31	4	Psychology of Stress	R	R	E	R				
35	5	Emergency Response	R		E	E	E			
37	6	Environmental Safety	E	E	E	E	E	E		
49	7	Environmental Laws and Regulations	E	E	E	E	E	E		
61	8	Environmental Science	E	E	E	E	E	E	E	E
77	9	Energy Sources	R			R		R		
79	10	Environmental Assessment	E	E	E	R	E	E	R	E
89	11	Plant Science		E		R		E	E	R
105	12	Soil Science	E	E		E	E	E	E	R
119	13	Hydrology	E	E		R	E	E	R	E
125	14	Pollution Control I	E	E	R	E		R	R	
129	15	Pollution Control II	E	E	E	E	E	E		
139	16	Chemical Technology	E	E	E	E	E	E	R	
153	17	Environmental Instrumentation	E	E	E	E	E	E		
173	18	Process Technology	E	R	R	R		R		
181	19	Electrical Basics	E	E	R	R				
185	20	Equipment Operation & Maintenance	R	E	R	E	E	E	E	R

BEST COPY AVAILABLE

PC =	Pollution Prevention and Control
ESA =	Environmental Sampling and Analysis
HS =	Health and Safety
ECA =	Environmental Compliance Assurance
HM =	Hazardous Materials Handling
WEM =	Water Environment Management
FWM =	Fishery and Wildlife Habitat Management
GIS =	Geographic Information Management System

Page #	Unit #	Unit	PC	ESA	HS	ECA	HM	WEM	FWM	GIS
191	21	Hydraulics & Pneumatics	R		R	E		E	R	
201	22	Surveying & Mapping	E	E		E	E	R	E	E
211	23	Drafting Technology	E		R	R		R	R	E
217	24	CADD Fundamentals	E			R			R	E
225	25	Waste Management	E	E	R	R	E	R		
245	26	Drinking Water Treatment Operations	E	E	E	E		E		
265	27	Wastewater Treatment Operations	E	E	R	E	R	E		
283	28	Hazardous Materials Management	E	E	E	E	E	R		
309	29	Wetlands Management	R	E	R	R		E	E	R
319	30	Watershed Management	E	E	E	R		E	E	R
325	31	Wildlife Ecology		E		R			E	
329	32	Wildlife Management				R			E	
347	33	Fisheries Management		E		R		E	E	
355	34	Programming Theory		R		R				R
359	35	Database Management System Basics	R	E		E	R			E
365	36	Database Administration	R	R	R	R	R		R	R
375	37	Geographic Information Systems (GIS)	E	E		R	R	E	E	E
393	38	Communication	E	E	E	E	E	E	E	E
399	39	Basic Microbiology	R	E	E	R		E	E	

BEST COPY AVAILABLE

Unit 1: Technical Documentation

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM	I	P
GIS	I	P

Competency 1.1: Record technical information

Competency Builders:
Describe various documentation procedures
Read documentation procedures
Follow documentation procedures
Observe process
Ask open-ended questions
Record process (e.g., flowchart, step-by-step)
Compile relevant data
Identify parameters
Recognize patterns in data
Record accurate, truthful data
Compile cumulative reference notebook/record
Maintain logs, notes, and records
Measure appropriate parameters
Document violation and enforcement notices
Document test results

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	P	R
ESA	I	P
HS	P	R
ECA	P	R
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

Competency 1.2: **Compose technical reports**

Competency Builders:
Compose technical memoranda
Complete forms and checklists
Identify format or report form
Generate charts and graphs
Generate maps
Analyze data
Draw conclusions
Explain analytical methods used
Outline reports and procedures
Write executive summaries
Present reports and procedures

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

Competency 1.3: Communicate documentation to others

Competency Builders:
Describe operation(s) to others
Participate in meetings
Interact with customers
Consult with colleagues
Resolve complaints
Refer questions and issues to appropriate authority [E-BIL]
Interact with public on safety environmental, and health issues
Interact with personnel on safety, environmental, and health issues
Compose clear instructions
Interpret prints, diagrams, specifications, and drawings
Interpret charts and graphs
Interpret maps
Draft preventive maintenance and calibration procedures
Identify strategies for communicating with mass media
Describe strategies for communicating with mass media

Unit 2: Statistical Analysis

BIL: Essential – PC, ESA, HS, ECA, HM, GIS

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS	P	R

Competency 2.1: Apply basic statistics concepts [E-GIS]

Competency Builders:
Describe data collection methods
Collect data
Organize data by flow chart
Interpret data by cause and effect diagrams
Explain nominal, ordinal, interval, and ratio data
Explain mean, median, and mode
Explain significance of standard deviation and correlation coefficient
Explain normal distribution
Differentiate between prevention and detection
Explain statistical score (e.g., t. z)

BIL: Essential – PC, ESA, HS, ECA, HM, GIS

EDU:	**12**	**AD**
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	P	R
WEM		
FWM		
GIS	I	P

Competency 2.2: Interpret scattergrams

Competency Builders:
Develop scatter grams
Interpret for positive, negative, or no correlation between X and Y variables
Test for significance
Explain regression analysis

BIL: Essential – PC, ESA, HS, HM, GIS
Recommended – ECA

EDU:	**12**	**AD**
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS	I	P

Competency 2.3: Analyze probability theories

Competency Builders:
Explain classical probability
Explain empirical probability
Calculate probability for outcomes

BIL: Essential – PC, ESA, HS
Recommended – ECA, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	P
ECA	I	R
HM		I
WEM		
FWM		
GIS		

Competency 2.4: Determine control limits

Competency Builders:
Explain uses of precontrol
Calculate precontrol limits
Explain significance of the limits
Plot values on a precontrol chart
Explain "out-of-control" situation
Make decisions on green (good control range), yellow (reaching control limits) and red conditions (out of control)

BIL: Essential - PC
Recommended – ESA, HS, ECA, HM, GIS

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		I
WEM		
FWM		
GIS		I

Competency 2.5: Determine process capability

Competency Builders:
Measure X, R, USL, and LSL (upper and lower specification limits)
Calculate estimated process standard deviation
Plot right hand and left hand tail of process variation
Compute Z value for percent of probable defect for process
Calculate C_{PK} values that describe process capability
Describe skewed distributions
List probable causes of skewed distribution

BIL: Essential - PC
Recommended – ESA, HS, ECA, HM, GIS

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		I
WEM		
FWM		
GIS		I

Competency 2.6: Prepare control charts

Competency Builders:
Identify types of control charts
Interpret attribute data
Interpret histogram
Interpret scatter grams
Interpret NP chart
Interpret P chart
Interpret flowchart
Interpret cause-and-effect diagram
Construct P (percentage defective) chart for attributes
Plot control limits of P chart and data points
Check chart for out-of-control conditions
Construct an NP (number defective) chart with control limits and data
Construct C (count of defects) and U (number of defects per unit) charts
Check data on C and U charts
Construct flowchart
Construct cause-and-effect chart

BIL: Essential - ECA
Recommended – PC, HS, HM

EDU:	12	AD
PC	I	R
ESA		
HS	I	R
ECA	I	P
HM		I
WEM		
FWM		
GIS		

Competency 2.7: Construct X and R charts

Competency Builders:

Arrange data into statistical sub-groups
Explain importance of random sampling
Compute X (i.e., average of values) and R (i.e., range of values in subgroup) within sample
Plot in X and R on chart
Construct control chart with X (grand average) and R (average range) calculated
Calculate upper and lower control limits for X-chart
Calculate upper and lower control limits for R-chart

BIL: Essential – PC, ECA
Recommended – HS, HM

EDU:	12	AD
PC	I	P
ESA		
HS	I	R
ECA	I	P
HM		I
WEM		
FWM		
GIS		

Competency 2.8: **Evaluate X and R charts**

Competency Builders:
Plot percentages for normal distribution
Test distribution for normality
Explain difference between common cause and special cause
Explain "in-control" process
Explain significance of an out-of-control point on X or R chart
Identify patterns and trends on control chart
Identify run up and run down
Test for middle third on control chart
Explain significance of middle third on control chart
Explain Rule of Sevens

BIL: Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 2.9: Conduct process improvement studies

Competency Builders:

Analyze production methods and processes applying statistical process improvement techniques (e.g., SPC, C_{PK})

Identify appropriate statistical techniques for study (e.g., T-tests, F-test, capability, DOEX)

Identify major steps in conducting a study

Integrate results into the total system

Unit 3: Management & Supervision

BIL: Recommended – PC, ESA, HS, ECS, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS		I

Competency 3.1: Assess progress in assigned areas of responsibility/accountability

Competency Builders:

Set short- and long-term goals for assigned areas of responsibility/accountability
Demonstrate commitment to established goals and vision
Obtain support for goals
Provide support for goals
Monitor goal achievement
Adjust goals
Communicate goal achievement
Recognize goal achievement

BIL: Recommended – PC, ESA, HS, WEM, FWM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		I
GIS		I

Competency 3.2: Hire staff

Competency Builders:

Develop plans and procedures for identifying staffing needs
Identify staffing needs in accordance with plans
Develop job descriptions
Develop hiring and promotion policies and procedures in compliance with state and federal employment laws
Establish guidelines for selecting the most qualified person for a specific position
Identify state and federal employment laws and company hiring policies and procedures
Identify resources for locating candidates
Recruit candidates
Identify most appropriate candidates for position in accordance with established guidelines
Interview candidates for position
Follow up on information provided on job applications
Recommend or select applicants for employment
Orient new employees
Maintain personnel records
Explain unconventional work schedules (e.g., flextime, shared positions)
Identify additional or alternative employee benefits that the company might consider furnishing to employees

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM		I
WEM		I
FWM		I
GIS		I

Competency 3.3: **Supervise employee performance**

Competency Builders:
Apply management/leadership style appropriate for situation
Clarify roles and relationships using organizational charts
Communicate performance expectations
Clarify company policies and procedures
Create and maintain an environment supportive of productivity
Establish office procedures
Maintain office procedure manual(s)
Monitor employee performance
Maintain performance records
Document personnel issues
Evaluate employee performance
Provide employees with constructive criticism and feedback
Explain union role and responsibility
Counsel employees
Discipline employees
Make recommendations based on employee performance (e.g., transfer, promotion, or dismissal)
Manage the change process (e.g., for right-sizing, technological updating, globalization, retraining)
Identify company policies and federal laws governing discrimination and harassment
Demonstrate sensitivity to diversity, including differences in gender, culture, race, language, physical and mental challenges, and family structures
Explain motivational theory in selecting management techniques

BIL: Recommended – PC, ESA, HS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		
FWM		
GIS		

Competency 3.4: Design employee development activities

Competency Builders:

Analyze employee development needs (e.g., retraining, updating, stress management)

Select development strategies designed to meet individual and group needs

Identify the benefits of employee development activities offered outside the organization

Secure personnel resources, materials, and equipment needed for employee development activities

Monitor employee development activities

Keep employees informed about development opportunities

Encourage employee participation in development activities

Evaluate employee progress

Provide feedback to employees concerning their progress

Provide formal and informal recognition for employee development

BIL: Recommended – PC, ESA, HS, WEM, GIS

EDU:	12	AD
PC	I	R
ESA	I	R
HS		I
ECA		
HM		
WEM		I
FWM		
GIS	I	R

Competency 3.5: Manage work flow and operations

Competency Builders:

Plan physical layout and work flow
Develop business or job procedures/operations flowcharts
Prioritize work
Establish and maintain operating policies and procedures
Establish and maintain production standards
Establish and maintain linkages with other departments
Systematize work
Delegate work
Communicate operating policies and procedures, priorities, linkages, and standards to others
Assign work
Monitor progress
Solve work flow/operations problems
Prepare productivity reports
Communicate contents of productivity reports to others

BIL: Essential – ECA, WEM, FWM
Recommended – PC, ESA, HS, HM, GIS

EDU:	**12**	**AD**
PC		I
ESA	I	R
HS		I
ECA	I	P
HM	I	R
WEM	P	R
FWM	P	R
GIS	I	R

Competency 3.6: **Plan meetings**

Competency Builders:
Set agenda
Schedule meeting
Reserve meeting room
Invite appropriate personnel
Identify need for outside speakers
Assign someone to take minutes

BIL: Essential - ECA
Recommended – PC, ESA, HS, HM, WEM, FWM, GIS

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA	I	P
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

Competency 3.7: Conduct meetings

Competency Builders:
Make introductions
Invite questions, comments, and group participation
Record appropriate action, time frame, and person accountable for identified tasks
Monitor time
Publish minutes in timely manner

BIL: Essential – FWM
Recommended – PC, ESA, HS, ECA, WEM, GIS

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA	I	R
HM		
WEM	I	R
FWM	I	P
GIS	I	R

Competency 3.8: Conduct public relations activities

Competency Builders:
Plan facility tours for the public
Answer press and public inquiries
Reassure the public if a potential emergency situation arises
Identify target audiences
Assess information needs
Coordinate multimedia promotional programs
Prepare articles for publication
Respond to interview requests
Coordinate public displays
Deliver public presentations (e.g., radio and T.V.)
Prepare media releases
Coordinate events
Prepare environmental status reports
Organize open houses and tours
Coordinate information sessions
Develop public awareness campaigns/programs
Explain the concept of adult education

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

Competency 3.9: Manage budgets

Competency Builders:
Identify the costs of operation
Perform cost surveys
Develop a plan for efficient operations
Explain system-efficiency balance
Identify budget activities and categories of expense accounts
Identify techniques of budget control
Identify statements about budget related activities
Identify factors that are needed to maintain adequate control over supplies on hand and on order
Develop productivity goals
Implement productivity goals
Develop attainable tasks/time estimates

BIL: Essential - HS
Recommended – PC, ESA, ECA, HM, WEM, GIS

EDU:	**12**	**AD**
PC	I	R
ESA		I
HS	I	P
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

Competency 3.10: Develop standard operating procedures (SOPS)

Competency Builders:

Plan and implement an in-house training program that includes safety measures and hazardous or toxic materials in the work place (e.g., HAZ, Com, CHP)
Plan and implement a cross-training program in facility operations
Plan and implement a SOP for a job-related task

BIL: Recommended – PC, ESA, HS, WEM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		
GIS		I

Competency 3.11: Develop facility process optimization and management plans

Competency Builders:

Develop a plan for inventory control

Develop a plan for an analysis of operation and maintenance logs and for the optimum operation of equipment

Develop a plan for facility automation

Develop a plan to achieve efficient, energy-saving, cost-effective operations

Develop a plan for testing and analyzing treatment operations

Develop a plan for the systematic troubleshooting of operations problems

Develop a plan for documenting operations that anticipates and avoids potential problems

Identify facility equipment

Develop a facility staffing plan

Develop a procedure for quality assurance/quality control in a facility

Develop a procedure for obtaining certification for a facility

Develop a sampling/analysis schedule based on sampling requirements

BIL: Essential – ESA, FWM
Recommended – ECA, HM, WEM

EDU:	12	AD
PC		
ESA	I	P
HS		
ECA		I
HM		I
WEM	I	R
FWM	I	P
GIS		

Competency 3.12: Explain federal, state, and local rules

Competency Builders:
Explain operational rules
Apply facility management rules
Apply samples and analyses rules

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		I
HM		I
WEM		I
FWM		I
GIS		I

Competency 3.13: Correct facility operational problems

Competency Builders:
Troubleshoot operational problems
Check the accuracy of observed operational problems
Identify appropriate corrective actions for operational problems
Monitor results of corrective actions taken
Identify actions that should be taken to prevent recurrence of identified operational problems

BIL: Essential – PC
Recommended – ESA, ECA, HM, WEM, FWM, GIS

EDU:	**12**	**AD**
PC	I	P
ESA	I	P
HS		
ECA		I
HM		I
WEM		I
FWM		I
GIS	I	R

Competency 3.14: Manage environmental operations

Competency Builders:
Balance environmental costs and benefits
Explain scope of environmental projects
Investigate complaint
Implement corrective action
Resolve issue with concerned party
Document investigation and rules

BIL: Essential – PC, HS
Recommended – ESA, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	R
WEM		I
FWM		I
GIS	I	P

Competency 3.15: Develop contingency plans

Competency Builders:
Analyze potential emergency situations that can occur in a facility
Develop a plan for handling problems caused by emergency situations, including what equipment would be used and what sampling would be needed
Develop a procedure to ensure employee safety
Develop procedures to ensure continuous operations (e.g., preventive maintenance)
Practice deployment plan

Unit 4: Psychology of Stress

BIL: Recommended – PC, ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 4.1: Analyze factors that influence response to stress

Competency Builders:
Describe stress
Differentiate between stress and stressors
Analyze how an individual's perception of stress influences response to stressors
Analyze how internal and external mitigating factors influence one's response to stress
Analyze coping mechanisms used to decrease stress

BIL: Essential - HS
Recommended – PC, ESA, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	P
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 4.2: Analyze physiological response to stress

Competency Builders:

Describe the stress response on the body systems (e.g., autonomic, nervous, endocrine)
Analyze how mitigating factors relate to the physiological stress response
Differentiate between immune system response to stressors in children and adults
Describe how stress relates to activation of the disease process
Identify biological adaptive responses to stress

BIL: Recommended – PC, ESA, HS, ECA, WEM

EDU:	**12**	**AD**
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 4.3: Analyze psychological response to stress

Competency Builders:
Identify psychological stressors
Identify causes and characteristics of post catastrophic stress
Analyze the relationship between personality types and the stress response
Analyze types of coping strategies
Identify selected defense mechanisms
Analyze ineffective coping behaviors
Explain the psychobiologic response of anxiety as it relates to stress
Describe the disequilibrium associated with response to stressors
Describe stress as it relates to teams organizations and groups
Analyze how individual perception of stress influences relationships

Unit 5: Emergency Response

BIL: Essential – HS, ECA, HM
Recommended - PC

EDU:	12	AD
PC	I	R
ESA		
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 5.1: Identify various emergency response plan requirements for a facility

Competency Builders:
Evaluate hazards
Evaluate and implement evolving contingency plans such as SPCC
Develop site command/operating procedures
Identify mitigation techniques
Participate in field exercises (e.g., drum handling, instrumentation surveying, decontamination procedures, personal protective equipment, medical evaluations)
Identify training needs for emergency responders
Document training
Comply with federal, state, and local regulations

BIL: Essential – HS
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		
HS	I	P
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 5.2: Develop an emergency response plan for natural disasters

Competency Builders:
Assess seriousness of incident
Identify information to be released to public and media
Coordinate efforts with other response agencies
Demonstrate clean–up activities
Identify mitigation techniques
Provide first response training
Document training

Unit 6: Environmental Safety

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.1: Identify general workplace safety hazards [E-HS]

Competency Builders:

Identify types and potential level of workplace hazards (e.g., physical hazards, fire, chemicals, noise, ionizing radiation, ultraviolet, temperature extremes, ergonomics, biological hazards, non–ionizing radiation, lasers, microwaves, electro magnetic fields)
Identify safety materials/equipment and transportation (e.g., absorbent socks, oil dry)
Explain purpose(s) of OSHA, NIOSH, NFPA and DOT
Identify purpose of emergency evacuation routes, master switch, lockout locations, and safety color coding systems
Identify methods of site protection
Describe methods of evaluating potential hazards (e.g., visual analysis)
Describe methods of correcting potential hazards
Describe corrective procedures for unsafe conditions
Explain precautions required when using toxic or flammable materials
Describe various types of toxicity (e.g., chronic, immediate)
Explain confined space and related requirements

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	P	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.2: **Apply general workplace safety precautions/procedures** [E-HS]

Competency Builders:
Identify local, state, and federal rules and regulations
Identify roles of industrial hygienists, safety professionals, occupational physicians, and occupational nurses
Identify personal protective wear and equipment
Identify level of personal protective wear required
Identify visual controls (e.g., monitors, read outs)
Identify auditory controls
Interpret hazardous materials notices on containers
Wear personal protective clothing and equipment
Apply workplace safety rules and procedures
Apply personal safety rules and procedures
Apply workplace organization (e.g., housekeeping)
Apply applicable electrical, mechanical, steam, hydraulic and pneumatic safety rules and procedures
Apply fire safety rules and procedures
Interpret material safety data sheets (MSDS)
Perform lockout and tagout
Complete preventive maintenance checklists
Complete confined space entry check sheets
Obtain training for confined space entry
Explain OSHA 1910 requirements

BIL: Essential – ECA, HM, WEM
Recommended – PC, ESA, HS

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.3: Acquire and maintain first aid certification

Competency Builders:
Assist patient with wounds or fractures
Administer first aid to control bleeding
Administer first aid for shock
Administer first aid for burn patient
Assist with first aid for poisoned patient
Assist choking patient
Assist patient having a seizure
Assist patient having a diabetic reaction
Assist syncopal patient
Identify protection from blood-born pathogens

BIL: Essential – ECA, HM, WEM
Recommended – PC, ESA, HS

EDU:	12	AD
PC	I	R
ESA		P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 6.4: Acquire and maintain cardiopulmonary resuscitation (CPR) certification

Competency Builders:
Administer CPR to adults
Administer care for obstructed airways for adults

BIL: Essential - ESA, GIS
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS	I	P

Competency 6.5: Respond to medical emergencies

Competency Builders:
Perform head to toe assessment
Describe signs and symptoms of emergency situations
Identify basic emergency procedures and equipment
Contact local emergency assistance
Demonstrate first responder procedures
Identify evacuation techniques

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 6.6: Explain purpose of pollution control systems

Competency Builders:

Describe types of air, water, solid waste, and noise pollution
Explain purpose of air pollution control systems
Explain purpose of water pollution control systems
Explain purpose of solid waste pollution control systems
Explain purpose of noise pollution control systems
Explain basic philosophy of "Right to Know" legislation
Explain purpose(s) of regulatory agencies (e.g., EPA, ODH, ODNR, Army Corp.)
Identify "costs" of industrial pollution control (i.e., dollars vs. impact to environment)
Describe ethics of environmental issues

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 6.7: Describe procedures to comply with environmental regulations

Competency Builders:
List characteristics of an effective monitoring program
Differentiate among environmental laws (i.e., CAA, CWA, RCRA, CERCLA, SARA, PPA, TSCA)
Describe procedures for search warrants, administrative warrants, and criminal search warrants
Prepare for environmental audit, including multimedia
Identify process used to develop laws and regulations
Identify process used to develop policies and procedures
Document procedures
Describe procedure for monitoring systems
Complete compliance reports
List permit requirements as related to leacheate production and control
List permit requirements as related to vector control, landfill gas and settlement

BIL: Essential – PC, ESA, HS, ECA, HM
Recommended - WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	R
FWM		
GIS		

Competency 6.8: **Maintain environmental health and safety facilities**
[E-HS]

Competency Builders:
Perform safety inspections
Participate in safety audits
Participate in safety, health, radioactive and environmental training
Participate in safety demonstrations, drills, and meetings
Identify safety monitoring equipment
Describe unsafe or potentially unsafe conditions, and acts
Respond to emergencies, alarms, and any abnormal situations
Describe potential health or industrial hygiene problem reporting procedures
Implement federal, state, and local legislation pertaining to environmental, health, and safety regulations
Identify evacuation procedures, emergency numbers, rules, and practices
Identify procedural problems in the workplace
Describe the purpose of various safety related permits
Identify correct material handling procedures

BIL: Essential – PC, ESA, HS, ECA, HM
Recommended - WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	R
FWM		
GIS		

Competency 6.9: Handle chemicals and safety equipment appropriately

Competency Builders:
List proper safety equipment (e.g., proper hoods, shields)
Identify appropriate protective equipment (e.g., eye wear, special clothing)
Identify specific categories of hazardous chemicals
Identify hazards associated with collecting samples
Refer to chemical reference handbooks
Label all chemicals, materials, tools, and equipment with appropriate safety, health, and environmental details
Explain importance of appropriate display of warning labels
Demonstrate safe handling of materials under pressure
Explain the hazard symbols and toxicology sections of MSDS
Demonstrate safe handling procedures (e.g., handling cylinders, moving heavy items)
Classify chemicals according to reactivity
Identify incompatible combinations of chemicals that could result in potentially dangerous situations
Organize and store chemicals and equipment properly

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM		
GIS		

Competency 6.10: Explain ergonomic procedures [R-HS]

Competency Builders:

Explain risk factor
Explain maximum permissible limit (MPL) and action limit (AL) for lifting (i.e., NIOSH Guide for Lifting)
Identify cumulative trauma disorder (CTD)
Identify susceptibility factors for CTD
Identify ways to minimize extreme joint movement
Identify ways to minimize use of excessive muscle force
Identify ways to minimize repetitive tasks
Comply with repetitive strain standard (OSHA)
Identify ways to minimize mechanical stresses (e.g., sharp edges, heat, cold, hard surfaces, weights, vibration)
Identify ways to minimize awkward body positions
Explain importance of rest pauses
Explain importance of mats and footrest for standing jobs
Explain importance of appropriate working heights of chairs, stools, workbenches, equipment
Explain importance of adequate lighting
Explain importance of anthropocentric design principles (i.e., centering one's view of everything around man)

BIL: Essential – ESA, HS, ECA
Recommended – PC, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	R
WEM	I	R
FWM		
GIS		

Competency 6.11: **Assess workplace safety**

Competency Builders:
Describe a work place inspection applying Occupational Safety and Health Administration (OSHA) standards
Cite specific regulations and standards for items not in compliance
Develop a written plan of alternative solutions or corrective actions
Prepare cost and cost benefit statements for specific corrective actions
Analyze accident incidence statistics
Explain the purpose and function of a safety committee
Explain how unions and employee organizations impact on safety procedures
Develop a site safety plan

BIL: Essential – ESA, HS, ECA
Recommended – PC, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	R
WEM	I	R
FWM		
GIS		

Competency 6.12: **Assess a safety-training plan**

Competency Builders:

Identify job skills or tasks required of different occupations or positions in a work place
Identify OSHA Regulations requiring safety training programs
Develop an outline to train workers to work safely and efficiently
Develop training activities for identified skills that will reduce or eliminate injuries
Develop a job related pre-test and post-test to document competency
Explain the purpose of a job safety analysis (JSA)
Construct a JSA of the activities of a specific worker in a specific industry
Complete an incident report
Develop an incentive program

Unit 7: Environmental Laws and Regulations

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		I
ECA	I	R
HM	I	P
WEM	I	R
FWM		
GIS		

Competency 7.1: **Identify key components of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)**

Competency Builders:
List sections of CERCLA
List key parts of CERCLA site evaluation and remedy selection
List the scores involved with the hazard ranking system and their characteristics
Explain national priority site identification (NPL)
List key elements of toxic substance control act (TSCA) relative to CERCLA

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		I
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 7.2: **Identify requirements of Superfund Amendment Reauthorization Act (SARA)**

Competency Builders:
List sections of SARA
List key parts of SARA
Explain Toxic Release Inventory (TRI)

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	I	R
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 7.3: Identify roles and functions of government

Competency Builders:

Identify the roles and responsibilities of federal, state, and local government
Identify the difference between enabling legislation and implementing regulations
Explain the role of public involvement and participation (public notice, public hearing, public comment)

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 7.4: Identify requirements of waste and material transportation

Competency Builders:

Identify generator requirements to transfer hazardous materials and waste to treatment, storage, and disposal facilities

List key elements of C.F.R. 49

BIL: Essential – PC, ESA, HS, ECA, HM
Recommended - WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 7.5: Describe job-related activities subject to the Occupational Safety and Health Administration (OSHA)

Competency Builders:

Describe OSHA rules and regulations

Describe commercial diving operations involving the environmental field (IAW OSHA 29 CFR 1910.424)

Describe OSHA 29 CFR 1910.1000 Z Tables

Describe OSHA requirements applicable to blood borne pathogens (IAW OSHA 29 CFR 1910.1250)

Describe requirements set forth under Hazard Communication Laws and Regulations (IAW OSHA 29 CFR 1910.1200)

Describe noise exposure limits (IAW OSHA 29 CFR 1910.95)

Describe use and function of portable fire extinguisher (IAW OSHA 29 CFR 1910.157)

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

Competency 7.6: **Describe requirements of Resource Conservation and Recovery Act (RCRA)**

Competency Builders:
List sections of RCRA
List key components of RCRA
Identify categories of hazardous waste
Describe "cradle to grave" concept
Identify secondary containment requirements for above and below ground storage

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 7.7: Explain requirements of Clean Water Act

Competency Builders:
List sections of Clean Water Act
List key components of CWA
Identify key components of National Pollutant Discharge Elimination System
Identify key components of 503 Sludge Regulations
Explain pre treatment program
Describe the Great Lakes Initiative (GLI)

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended - HS

EDU:	**12**	**AD**
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 7.8: **Explain requirements of Safe Drinking Water Act (SDWA)**

Competency Builders:
List sections of SDWA
List key components of SDWA
Explain purpose of Wellhead Protection Program
Describe Sole Source Aquifer Designation

BIL: Essential – PC, ESA, ECA, HM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 7.9: Explain requirements of Clean Air Act

Competency Builders:
List sections of CAA
List key components of CAA, Chrome Reporting, and MACT's
Explain Title V Air Emissions Inventory and Permitting
Explain hazardous air pollutants (HAPs)

BIL: Recommended – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		I
HM	I	R
WEM		
FWM		
GIS		

Competency 7.10: Identify requirements of the Nuclear Waste Policy Act

Competency Builders:
List key provisions of Nuclear Waste Policy Act
List key agencies involved in high-level radioactive waste management program
List defining characteristics of four categories of nuclear waste
List method of disposal for each category of nuclear waste
Identify locations of storage for each type of nuclear waste

BIL: Essential – PC
Recommended – HS, ECA, HM

EDU:	**12**	**AD**
PC	I	P
ESA		
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 7.11: Identify key components of ISO 14000

Competency Builders:
List standards of ISO 14000
Explain purpose of ISO 14000
Explain impact of ISO 14000

Unit 8: Environmental Science

BIL: Essential – PC, ESA, HM, WEM, FWM
Recommended – HS, ECA, GIS

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	IR	R

Competency 8.1: Identify the components of the earth's atmosphere

Competency Builders:
Describe the composition of the atmosphere
List the most abundant gases by percent volume which make up the composition of clean, dry air
Explain how water vapor varies within the atmosphere
List the major cycles of atmospheric gases
Explain the relationships that exist within the cycles of atmospheric gases
Describe the dependence of organisms on the atmosphere
Explain the importance and impact of water vapor in air

BIL: Essential – PC, ESA, HM, GIS
Recommended – ECA, WEM, FWM

EDU:	12	AD
PC	I	P
ESA	P	R
HS		
ECA	P	R
HM	P	R
WEM	I	R
FWM	I	R
GIS	P	R

Competency 8.2: Explain meteorology

Competency Builders:
Explain how the atmosphere is composed of layers of air of varying temperatures
Differentiate among conduction, convection, and radiation
Differentiate between convection movement and general air circulation
List reasons for unequal heating of the earth's surface (land and water)
Explain how latitude affects the amount of energy received from the sun
Differentiate between weather and climate
Explain how mountain ranges affect climate
Differentiate between continental and marine climates
Identify the processes in the water cycle
Explain how humidity relates to the amount of water vapor in the air
Describe how air masses form
Explain the relationship of fronts to air masses
Differentiate fronts, temperature, and pressure on a weather map legend
Identify weather instruments (e.g., barometer, thermometer, anemometer) and atmospheric conditions that they measure
Identify the major kinds of clouds (e.g., cirrus, cumulus, stratus, and nimbus)
Identify causes of hurricanes, tornadoes, and thunderstorms
Describe the characteristics of hurricanes, tornadoes, and thunderstorms
Describe the function of the ozone layer
Describe the impact of technology on the ozone
Interpret a weather map
Record measurements of local rainfall, temperature, air pressure, relative humidity, cloud cover and type, and wind speed
Explain the Greenhouse Effect

BIL: Essential – PC, ESA, HM, WEM, FWM
Recommended – HS, ECA, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	R

Competency 8.3: Determine the quality and quantity of water resources

Competency Builders:

Identify present and potential sources of water pollution (e.g., point and non-point sources)
Identify present and potential sources of water pollution in local area
Evaluate quality of given sample of water
Calculate the volume and surface area of ponds, lakes, and streams
Plan improvements of waterways, ponds, stream banks, and shorelines
Determine stream flow
Collect water samples from a representative test site
Label water samples from a representative test site
Store water samples from a representative test site
Determine the quality of water samples by measuring for pH, turbidity, dissolved solids and dissolved oxygen, visual observation
Investigate watershed boundaries and drainage patterns
Monitor water levels of rivers, streams, ponds and lakes
Monitor erosion hazards and environmental quality
Determine quality of water samples by examination of particles

BIL: Essential – PC, ESA, HM, WEM, FWM, GIS
Recommended – HS, ECA

EDU:	12	AD
PC	P	R
ESA	P	R
HS	I	R
ECA	I	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.4: **Outline the movement and distribution of water in the environment**

Competency Builders:

List the areas of distribution of the earth's water
List the properties of water
Differentiate between suspensions and solutions
Illustrate the polar covalent bond between the hydrogen and oxygen atoms in a water molecule
Describe the three physical states of water
Explain evaporation, humidity, and condensation
Illustrate the hydrological cycle and its processes
Identify the functions and uses of water in the environment

BIL: Essential – ESA, HM, WEM, FWM, GIS
Recommended – PC, HS, ECA

EDU:	**12**	**AD**
PC	I	R
ESA	P	R
HS	I	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.5: **Analyze the relationships between plants and animals within ecosystems**

Competency Builders:
Illustrate the major categories of organisms
Differentiate among biomes
Differentiate among types of ecosystems
Explain the dynamic nature of ecosystems
Identify the functions of producers and consumers
Explain how biotic and abiotic factors affect producers and consumers
Compare the growth and development of various types of plant forms
Categorize the various forms of animal life
Describe the interactions between producers, consumers, decomposers, and antagonists
Illustrate a food chain and food web

BIL: Essential – PC, ESA, WEM, FWM, GIS
Recommended – HS, ECA

EDU:	12	AD
PC	P	R
ESA	P	
HS	I	R
ECA	I	R
HM		
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.6: Analyze the character and value of natural resources

Competency Builders:
Describe the value of natural resources
Describe the major categories of natural resources
Describe the types and distributions of natural resources
Contrast the origins of natural resources
Differentiate between renewable and non-renewable natural resources

BIL: Essential – ESA, WEM, FWM, GIS
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	P	
HS	I	R
ECA	I	R
HM	I	P
WEM	P	R
FWM	P	R
GIS	P	

Competency 8.7: Distinguish between renewable and non-renewable natural resources

Competency Builders:
Explain renewable natural resources
Explain the major categories of renewable natural resources
Identify the origins of renewable natural resources
Describe the value of renewable natural resources
Explain non-renewable natural resources
Explain the major categories of non-renewable natural resources
Identify the origins of categories of non-renewable natural resources
Describe the value of non-renewable natural resources

BIL: Essential – ESA, WEM, FWM, GIS
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA	I	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.8: Evaluate the exploitation of natural resources

Competency Builders:
Evaluate natural events that alter the environment
Evaluate various methods used to obtain natural resources
Evaluate the effects of obtaining natural resources on the environment
Identify the primary factor for the exploitation of natural resources
Identify the technological advances contributing to the exploitation of natural resources by industry
Identify the technological advances contributing to the exploitation of natural resources by agriculture
Identify the transportation advances contributing to the exploitation of natural resources

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, GIS

EDU:	**12**	**AD**
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	P	R
WEM	I	R
FWM		
GIS	I	R

Competency 8.9: **Describe how alternative energy sources can reduce fossil fuel consumption**

Competency Builders:
Describe the operation of a solar water distiller
Describe the operation of a solar oven
Describe the operation of a wind generated water pump
Describe the operation of a sundial
Describe the mechanical operation of a solar hot water heater
Describe advanced solar technology
Describe alternative energy sources and technology

BIL: Essential – PC, ESA, GIS
Recommended – HS, ECA, HM, WEM, FWM

EDU:	12	AD
PC	P	R
ESA	P	R
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	P	R

Competency 8.10: Evaluate the impact of an increasing human population on the environment and humans

Competency Builders:

Explain how the history and growth of the human population during the past four thousand years has affected the environment

Explain doubling time, natural increase, natural decrease, rate of population change, and zero population growth

Interpret a population profile

Compare the population profile of a developing country to one of a developed country

Analyze the relationship between a country's economic status and its population

Identify the results of increases in the population on the environment

BIL: Essential – PC, ESA, HS, ECA, WEM, FWM, GIS
Recommended – HM

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	I	R
HM	I	R
WEM	P	R
FWM	I	R
GIS	P	R

Competency 8.11: Evaluate the consequences of resource use and abuse on the environment

Competency Builders:

Identify the results of overuse that occurred from exploitation
Trace the effects of pollution through a food chain
Differentiate between biodegradable and non-biodegradable products
Differentiate between organic farming and farming practices that incorporate the use of biocides and inorganic fertilizers and their comparative effects on the environment
Describe solid waste disposal methods and groundwater contamination
Explain how fossil fuels contribute to acid rain and petrochemical pollution
Evaluate pro and con attributes of nuclear energy
Describe impact of resource use and abuse on air quality
Describe impact of resource use and abuse on water quality
Describe impact of resource use and abuse on soil productivity
Identify several causes for the reduction of habitat
Differentiate among the various types of habitat
Analyze why preservation of habitat is essential
List examples of threatened, endangered, introduced, extinct and extirpated plant and animal species
Evaluate causes for the decrease of both plant and animal species
Explain factors contributing to accidental resource abuse
Explain factors contributing to incidental resource abuse
Explain factors contributing to deliberate resource abuse

BIL: Essential – PC, ECA
Recommended – HS, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA		
HS	I	R
ECA	I	P
HM	I	R
WEM	I	R
FWM	I	R
GIS	IR	P

Competency 8.12: Identify the impact of individuals/organizations on the development of environmental policies and issues

Competency Builders:
List prominent individuals/organizations involved with environmental issues
Explain current trends in property rights and compensation
Identify the major issues addressed by environmental organizations
Identify major incidents that have resulted in legislation
Evaluate results of environmental restoration and conservation efforts
Identify pros and cons of environmental organizations

BIL: Essential – PC
Recommended – ESA, HS, ECA, WEM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS	I	R

Competency 8.13: Evaluate the effects of research and education on environmental issues

Competency Builders:

Identify the methods of research used by both public and private agencies in restoration and conservation efforts
Identify the process used in restoration and conservation research
Explain the interrelationship between research and education
Evaluate the outcome of environmental research projects

BIL: Essential – PC
Recommended – ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	**12**	**AD**
PC	I	P
ESA	I	R
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

Competency 8.14: Evaluate government's role in environmental restoration and conservation

Competency Builders:
Evaluate the effects legislation has had on the environment
Identify federal and state agencies and their roles in restoration and conservation

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	R
FWM	I	R
GIS	I	R

Competency 8.15: Evaluate the impact and implications of environmental restoration, preservation and resource conservation

Competency Builders:

Evaluate the importance of environmental restoration, preservation and conservation

Cite examples of various levels of environmental restoration, preservation and conservation

Evaluate the results of environmental restoration, preservation and conservation

Identify economic issues of environmental restoration, preservation and conservation projects

Identify non-economic benefits of environmental restoration, preservation and conservation activities

BIL: Essential – PC, ESA, HS, ECA, GIS
Recommended – HM, WEM, FWM

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	I	P
HM	I	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 8.16: Evaluate the role of responsible stewardship in maintaining a healthy environment

Competency Builders:
Describe responsible stewardship
Evaluate the need for responsible stewardship and environmental accountability
Identify types of environmental accountability and cite examples of each
Cite results stemming from responsible stewardship

Unit 9: Energy Sources

BIL: Recommended – PC, ECA, WEM

EDU:	12	AD
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

Competency 9.1: **Identify conventional energy sources and their environmental impact**

Competency Builders:

Identify natural gas resources and their environmental impact
Identify coal resources and their environmental impact
Identify petroleum resources and their environmental impact
Identify nuclear resources and their environmental impact
Identify hydroelectric resources and their environmental impact

BIL: Recommended - PC, ECA, WEM

EDU:	**12**	**AD**
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

Competency 9.2: **Identify alternate energy sources and their environmental impact**

Competency Builders:

Identify geothermal resources and their environmental impact
Identify wind resources and their environmental impact
Identify solar energy resources and their environmental impact

Unit 10: Environmental Assessment

BIL: Essential - ESA
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 10.1: Gather data for assessment (Phase I)

Competency Builders:
Identify key elements in Phase I, II, and III assessments
Describe the importance of a title search
Gather drainage area data
Complete field data sheet
Record physical and topographical data
Interpret basic soil differences
Measure ground water level
Identify flood plain areas
Measure stream flow
Complete a title search
Calculate water run off

BIL: Recommended – PC, ESA, ECA, HM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA		I
HM	I	R
WEM		
FWM		
GIS		

Competency 10.2: Identify past practices (Phase I)

Competency Builders:
Locate regulatory reference materials
Collect background information
Verify accuracy of information
Investigate background of complaint
Interact with various regulatory agencies
Refer to regulatory reference materials

BIL: Essential – PC, ESA, HS, HM, WEM, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM	I	P
FWM		I
GIS	I	P

Competency 10.3: **Collect physical data: composite; grab; continuous; remote sensing; grid; background; core; auto; biological; air and opacity (Phase II)**

Competency Builders:
Monitor protocol and procedures
Select appropriate equipment
Identify safety hazards of materials
Demonstrate procedures for safe sampling collection and handling
Develop "Chain of Custody" procedures
Develop a sampling plan
Describe federal and state sampling regulations
Follow appropriate preparation procedures
Follow appropriate marking procedures

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 10.4: **Conduct lab/field analysis: biochemical oxygen demand (BOD); chemical oxygen demand (COD); pH; specific conductivity; dissolved oxygen; suspended solids; nitrates and nitrites; air particulate; percolation.**

Competency Builders:
Measure water temperature
Measure water hardness
Measure water level and flow
Measure turbidity
Measure oxygen level (HS)
Measure Lower Explosive Levels (LEL) [R-HS]
Measure air flow rate and temperature [R-HS]
Describe procedures for measuring toxic gasses, organic vapors, and radiation [R-HS]
Measure toxic gases [R-HS]
Measure organic vapors [R-HS]
Measure basic field levels of contamination [R-HS]
Measure radiation [R-HS]
Sample for radon [R-HS]
Measure flashpoint [R-HS]
Measure free liquids
Measure moisture content/dry content (DC)
Measure density
Sample for chlorinated compounds
Identify background analytical data to establish norm for site

BIL: Essential – PC, ESA, HS, HM, WEM, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM	I	P
FWM		I
GIS	I	P

Competency 10.5: Analyze data

Competency Builders:
Draw conclusions from data
Write technical reports
Explain appropriate QA/QC procedures
Identify provisions of SW846

BIL: Essential – PC, ESA, HS, ECA, WEM, FWM, GIS
Recommended – HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	P
FWM	I	P
GIS	I	P

Competency 10.6: Demonstrate the use of fundamental of statistics in sampling practices

Competency Builders:
Distinguish a population
Demonstrate the steps of statistical analysis
Identify a random sample from a population
Explain the use a random numbers table

BIL: Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA		
HS	I	R
ECA		I
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 10.7: Identify procedures for site remediation

Competency Builders:
Interpret Data
Identify options
Resolve issue with concerned party(s)
Assess options for corrective action
Implement selected option for correction
Document investigation with summary reports
Identify health and safety activities

BIL: Recommended – PC, ESA, ECA, HM, WEM

EDU:	12	AD
PC		I
ESA		I
HS		
ECA	I	R
HM		I
WEM	I	R
FWM		
GIS		

Competency 10.8: Assess water systems

Competency Builders:
Complete a water quality assessment on a local surface water body
Complete a ground water quality assessment within a well head protection area
Develop a NPDES Plan for a construction site
Complete a surface water assessment within a watershed
Develop a primary and secondary containment system
Evaluate the efficiency of a treatment facility
Conduct a sediment study to determine best management practice

BIL: Essential – ESA
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 10.9: Assess air systems

Competency Builders:
Conduct air emission inventory
Monitor indoor air quality
Assess pollution control system
Monitor auto emissions
Monitor volatile organic compounds (VOC)

BIL: Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		
HS		I
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 10.10: Manage solid waste systems

Competency Builders:
Select a municipal solid waste site (MSW)
Audit a MSW
Identify resources available through recycled solid waste
Draft a proposal to improve the control of solid waste management
Develop and maintain satellite accumulation area (SAA)
Draft/revise a chemical hygiene plan (OSHA 29 CFR 1910.1450) [R-HS]

Unit 11: Plant Science

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	P	R
HM		
WEM	P	R
FWM	P	R
GIS		

Competency 11.1: Explain plant structure and uses

Competency Builders:

List the parts of the plant and their functions including: seed (embryo, cotyledon, groat), root (tuber, rhizome, stolon, corm, bulb), stem (xylem, phloem, pith), leaf (blade, lobe, cotyledon, auricle, ligule), meristem (apical, dominant, terminal, auxiliary bud), and flowers (anther, stamen, style, ovary)

Contrast dicots and monocots based upon meristematic locations and reproductive structures

Describe the uses of plants (e.g., food, feed, fiber, soil, wood, recreation, erosion control, nutrient recycling, medicinal, industrial-dyes, chemicals)

Differentiate among perennials, biennials and annuals

Differentiate between seed crops and vegetative crops

Describe the life cycle of a crop plant (i.e., from seed to vegetative stage to reproductive stage to seed)

Identify the characteristics used in plant identification (e.g., leaf type and arrangement, type of fruiting structures, type of root system, stem characteristics)

BIL: Essential – ESA, FWM
Recommended – ECA, WEM

EDU:	12	AD
PC		
ESA	P	
HS		
ECA	I	R
HM		
WEM	I	R
FWM	I	P
GIS		

Competency 11.2: Describe the physiology of plants

Competency Builders:

Identify the parts of a plant cell and the function of each part
Describe the process of photosynthesis
Describe the function of the chlorophyll molecule
Describe the process of respiration
Write a simplified word and symbol formula of photosynthesis and respiration
List conditions that affect photosynthesis
Compare the processes of photosynthesis and respiration
Explain the process of osmosis
Describe the basic make-up and function of carbohydrates (sugars and starches), lipids (fats and oils) and proteins (structural and enzymatic)

BIL: Essential – FWM
Recommended – ESA, WEM

EDU:	12	AD
PC		
ESA	I	R
HS		
ECA		
HM		
WEM	I	R
FWM	I	P
GIS		

Competency 11.3: Explain plant nutrition

Competency Builders:
Explain how available nutrients, leaching, element, organic fertilizer, and inorganic fertilizer impact plant nutrition [R-WEM]
Identify the primary elements and their functions in plant growth
Explain green manure crop
Explain the relationship of adequate fertilization to yields
Explain the relationship of tillering in grain crops
Explain the relationship of return on investment in crop production
Describe purpose of inoculation of legume seeds with nitrogen fixing organisms
Explain minimum, optimum, and luxury consumption of soil nutrients by the plant [R-WEM]
Compare nutrients in the soil versus what plants get from air and water

BIL: Recommended – ESA, FWM

EDU:	**12**	**AD**
PC		
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM		I
GIS		

Competency 11.4: Evaluate plant fertilization techniques

Competency Builders:
Identify the micro-nutrients needed in plants and their chemical symbols
Identify deficiencies caused by minor element deficiency
Differentiate between organic and inorganic fertilizers
Identify global uses of inorganic and organic fertilizers
Describe the pollution hazards associated with over fertilization
Evaluate the latest techniques used to dispense only required amounts of fertilizer for crops

BIL: Recommended – ESA, ECA, FWM

EDU:	**12**	**AD**
PC		
ESA	I	R
HS		
ECA	I	R
HM		
WEM		
FWM		I
GIS		

Competency 11.5: Identify environmental factors affecting plants

Competency Builders:

Identify external influences on plant growth
Explain photoperiodism and dormancy in plants
Evaluate the effects of plant hormones (e.g., auxins, gibberellins, and cytokinins) on plant growth
Evaluate the commercial uses of auxins
Describe the various tropic responses
Explain the cause of gnostic movement
List some warm and cool season crops
List optimum growth conditions for different types of plants
Explain how crops may be managed to maximize environmental resources (e.g., establishing crop canopies to intercept 100% of light energy prior to fruiting, planting at a date that ensures sufficient biomass to attain maximum yield)
Describe the influence of day length on plant growth
Explain how the cycle of the seasons influences plant growth
Identify how planting date, row spacing, and plant population affect crop yield and quality

BIL: Essential – WEM, FWM
Recommended – ESA, GIS

EDU:	12	AD
PC		
ESA	I	R
HS		
ECA		
HM		
WEM		P
FWM	I	P
GIS		I

Competency 11.6: Conduct vegetation analysis

Competency Builders:
Demonstrate the proper use of field instruments
Conduct a quadrant analysis
Conduct a line transect analysis
Conduct a belt transect analysis
Conduct a random pairs analysis
Perform a comprehensive ecological study of a forest

BIL: Recommended – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS		

Competency 11.7: Explain methods to improve plant seed quality

Competency Builders:

Explain how heredity, genetics, inbreeding, crossing, progeny, self-fertilization, cross-fertilization, mutation, hybrid, systemic pesticide, toxic, and vigor impact seed quality
Explain seed development, morphology and composition
List the characteristics of good seeds
Describe the factors that create poor seed quality
Describe the history of crop improvement
List major aims of plant breeders
Describe three methods of crop improvement
Identify state agency responsible for seed certification
Describe major points and economic aspects to consider when identifying varieties for planting
Explain the danger of monogenetic type crops (e.g., southern corn blight)
Evaluate the possible impact of genetic engineering
Describe breeding for pest resistance (insects, nematodes, and diseases)
Describe the classes of seed (e.g., breeders, registered, certified)
Differentiate between hybrid seed and seed from open pollinated or self-fed plants
Explain how a "hard seed coat" can be used to maintain high quality seed
Explain why plant breeding takes several years
Explain why breeders have to constantly be developing improved varieties

BIL: Recommended – ESA, FWM

EDU:	12	AD
PC		
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

Competency 11.8: Control weeds

Competency Builders:

List ways weeds spread
List reasons weeds are harmful
Explain the following methods of controlling weeds (e.g., mechanical, biological, IPM)
Explain mode of action of common herbicides
Explain weed resistance to herbicides
Evaluate possible applications of genetic engineering and gene splicing to weed control
Explain how a spray system works (pump, pressure regulator)
Explain how herbicides kill weeds
Explain why some herbicides are applied before or after a crop is planted
Explain why weed problems depend on when they occur during growing season of crop
Identify the major weed species and options available for controlling each
Apply herbicide(s)

BIL: Essential – WEM
Recommended – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		P
FWM		I
GIS		

Competency 11.9: Explain moisture control

Competency Builders:

Identify the impact of irrigation, mulch, organic matter, runoff, seepage, subsoiling, and tillage on moisture control
List three methods of moisture control
List the cultural practices used in moisture control (annually and at planting)
Describe importance of internal and external drainage in soils for crop production
Describe importance of irrigation to crops
Describe the methods of irrigation (e.g., drip, furrow, sprinkler, flood)
Explain the unique properties of water
Describe the world's water supply by volume and percent usable
Explain how irrigation causes salinity problems
Describe several regions of the world where salinity has stopped entirely or decreased crop production
Explain salt water intrusion in irrigation wells
Describe desalination possibilities for irrigation water
Explain subsidence caused by removal of irrigation water
Describe methods used to reduce irrigation water loss
Explain the use of tensiometers and moisture meters
Describe the idea of permaculture
Explain irrigation scheduling

BIL: Essential – FWM
Recommended – ESA, ECA, WEM

EDU:	12	AD
PC		
ESA	P	
HS		
ECA	I	
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 11.10: Classify plants

Competency Builders:

Describe the classifications system of living things according to the Kingdoms of Monera (Prokaryotic Cells), Protista (Eukaryotic Cells), Animalia, and Plantae
Describe the different levels of classification within the plant kingdom
Explain the differences in the classes Gymnospermae and Angiospermae
Explain Carolus Linnaeus' binomial system of classification for genus and species
Explain the significance of species plant breeding

BIL: Recommended – ESA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA		
HM		
WEM		
FWM		
GIS		

Competency 11.11: Evaluate the role of genetics in environmental systems

Competency Builders:

Describe the role played by chromosome, gene, DNA, RNA, genotypes, phenotypes, heterozygous, homozygous, alleles, hybrid, inbreeding, hybrid vigor, polyploidy, molecular biology, genetic engineering, genes, sexual crossing, genome, vectors, gene transfer, natural identification, artificial identification, heredity, chromosomes, gene-splicing, gene cloning, toxins, pathogens, and biological control in genetics
Describe mitosis
Describe meiosis
Explain incomplete dominance
Explain the cause of mutation
Describe the occurrence of multiple alleles
Explain the importance of mass identification
Describe the contributions of scientists to applied genetics (e.g., Burbank, Mendel)
Explain the "Green Revolution"
Evaluate the possible impact of genetic engineering to plant improvement
Evaluate possible applications of genetic engineering and gene splicing on pest control

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 11.12: Propagate plants

Competency Builders:
Contrast sexual and asexual propagation
Identify factors that affect seed germination
Describe mass propagation through tissue culture
Identify some of the pitfalls to avoid in propagating plants
Describe the soil chemical and physical properties that influence seed germination and emergency
Evaluate anthroculture and gene splicing as methods for genetic improvement
Explain biotechnology as it relates to plant improvement
Compare organic farming to standard production systems
Describe hydroponic crop production

BIL: Essential – FWM
Recommended – ESA

EDU:	12	AD
PC		
ESA		I
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 11.13: Identify plant diseases

Competency Builders:
Identify major causes of plant diseases
Identify the symptoms and effects of major diseases on plants
Identify several methods by which diseases are transmitted in plants
Identify environmental conditions that favor or hinder disease development

BIL: Recommended – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS		

Competency 11.14: Control plant diseases and pests

Competency Builders:
Explain the "disease triangle"
Evaluate cultural practices that may be used to prevent plant diseases
Evaluate the impact of genetic engineering on control of plant disease
Explain how chemicals control diseases
Evaluate how genetic resistance reduces production costs and potential environmental impact from spraying
Evaluate the economic importance of controlling plant diseases
Employ safety precautions in handling pesticides
Control plant diseases through fumigant, fungicide, resistance, sprays, dust, volatile, crop rotation, and sanitation
Identify control methods of plant pests (e.g., insects, slugs, worms, nematodes)

BIL: Essential – ESA, WEM, FWM

EDU:	**12**	**AD**
PC		
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 11.15: Explain aquatic biology

Competency Builders:

Identify and classify aquatic plants, including algae, fungi and aquatic insects
Explain eutrophication principles
Describe stream pollution and species diversity
Describe effects of algae on water quality

Unit 12: Soil Science

BIL: Essential – ESA, ECA, HM, WEM, FWM
Recommended – PC

EDU:	12	AD
PC	I	R
ESA	P	R
HS		
ECA	P	R
HM	P	R
WEM	I	P
FWM	I	P
GIS		

Competency 12.1: Describe soil geology

Competency Builders:
Identify the four major layers of the earth
Identify classes of rock (e.g., igneous, sedimentary, metamorphic)
Match rock classes with their mode of origin
Classify common rocks (e.g., sandstone, limestone, shale, slate, marble, quartzite, granite, obsidian)
Identify particles of varying size and density
Explain how materials deposited in the ocean form sedimentary rock
Explain how rocks change from one form to another
Explain the relationship of minerals to granite
Describe soil formation
Differentiate among the major types of parent material
Identify the factors that exert the most influence on soil formation
List the forms of plant life found in poor soil conditions
Explain how different climatic conditions affect soil formation
Differentiate between surface soil and subsoil
Identify the soil horizons in a soil profile

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	P	R
HS		
ECA	I	R
HM	I	R
WEM	I	R
FWM	P	R
GIS		

Competency 12.2: Describe composition of soil

Competency Builders:
List the main components found in a normal soil
Explain the composition of the solid part of the soil
Describe the main sources of organic matter
List the approximate percentage in which each of the soil properties is found in a normal soil
Differentiate between soil low in organic matter and soil high in organic matter
Explain the value of each soil component with regard to proper growth of plants

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	R
FWM	P	R
GIS		

Competency 12.3: Identify physical properties of soil

Competency Builders:

Interpret the organic matter content of the surface soil using soil color
Interpret internal drainage of the subsoil by observing soil color
Differentiate between "light" and "heavy" soils
Determine the texture of a soil sample
Classify soil samples using the textural triangle as a guide
Explain the effects of soil structure on productivity
Explain why dark color is not always due to organic matter content
Explain the effects of organic matter on soil structure
Describe the effects of soil structure on infiltration, percolation, and the potential for ground water contamination
Explain how soil type affects crop identification
Compare root restricting boundaries (plow pan, fragipan, etc.)
Describe factors that contribute to the information of tillage or traffic pans
Describe methods for alleviating traffic pans (e.g., subsoiling, reduced tillage, no-till)

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM	I	P
GIS		

Competency 12.4: Describe the biological properties of soil

Competency Builders:
List the biological properties of soils
Explain how biological properties affect the nature and conditions of soil
Identify the microorganisms
List the soil microorganisms
List the soil microorganisms beneficial to farmers
Describe the role of higher forms of plant and animal life in soil
Explain the nitrogen cycle and phosphorus cycle
Explain where the energy comes from to carry out the nitrogen transformations
Identify common bacteria in the nitrogen cycle
Explain the symbiotic relationship between bacteria and plants
Specify where bacteria are located in the root of the plants
Explain nitrogen fixation
Identify the roles of different types of bacteria in nitrogen fixation
Describe the concept of mineralization and immobilization of plant nutrients by soil microorganisms
Explain the biological effects on soils when amended with fertilizers, pesticides, and recyclable materials such as municipal wastes
Describe the effects of poor drainage or waterlogging on soil properties and plant growth

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM	I	P
GIS		

Competency 12.5: Describe the chemical properties of soil

Competency Builders:
List the chemical properties of soil
Explain how chemical properties affect the biological properties of soil and the nature and conditions of the soil
Explain the chemical effects on soils when amended with fertilizers, pesticides, and recyclable materials such as municipal wastes
Describe the effect of sand, silt, and clay content on water and nutrient holding ability of soils (CEC-cation exchange capacity)
Explain how charges on clay particles affect nutrient retention
Compare different types of clay to soil nutrient availability

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	**12**	**AD**
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	P	R
FWM	P	R
GIS		

Competency 12.6: Describe soil acidity and alkalinity

Competency Builders:

Create a chart of the pH scale to show degrees of soil acidity and alkalinity
Conduct laboratory tests for acidity of common products (e.g., fresh milk, sour milk, orange juice, and lemon juice)
Explain how calcium affects soil acidity and the availability of other elements
Explain how pH symbols are used in denoting the degree of acidity and alkalinity in soils
Describe the conditions that lead to soil acidity or alkalinity
List the pH ranges of the major crops
Explain how soil acidity or basicity is corrected
Explain how soil pH affects the availability of nutrients

BIL: Essential – ESA, FWM
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM	I	P
FWM	P	R
GIS		

Competency 12.7: Test soil samples to determine characteristics

Competency Builders:
Collect soil samples from test area
Complete soil data forms
Determine soil pH
Conduct soil mineral and elemental analysis
Record texture, structure, temperature, and color of each soil layer
Construct a soil micro monolith of a soil profile or soil pit
Analyze soil data
Write report

BIL: Essential – ESA, FWM
Recommended – PC, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		
HM		
WEM		I
FWM	I	P
GIS		

Competency 12.8: Explain liming to correct soil acidity

Competency Builders:
List the benefits obtained from liming a soil
List the steps involved in liming acid soils used for growing plants
Explain how lime reduces soil acidity
Explain how to determine the lime requirement for a specific crop
Identify different kinds of lime materials
Describe the appearance of plants growing in soils of different pH levels
List some sources of commercial lime
Describe different methods of applying lime and the type of equipment used
Formulate a liming schedule for various crops
Explain the effect of soil acidity on soil structure, water infiltration and soil aggregation
List some problems and effects associated with over-liming soil
Explain how lime particle size affects its ability to reduce soil acidity
List several materials that can be used to increase soil acidity or lower pH

BIL: Essential – ESA
Recommended – PC, ECA, FWM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA	I	R
HM		
WEM		
FWM	I	R
GIS		

Competency 12.9: Identify nutrient requirements of plants

Competency Builders:

Identify groups into which nutrient requirements of plants are divided
Describe the interactions of nutrient availability levels on nutrient toxicity and deficiency
Identify toxicity symptoms caused by excessive manganese and aluminum
Identify major sources of N, P, K, S, Ca, and Mg in soils
Identify factors that influence the availability of these nutrients in soils
Explain how soil pH affects nutrient availability
Explain how different types of root systems affect plant nutrient uptake

BIL: Recommended – PC, ESA, FWM

EDU:	**12**	**AD**
PC		I
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

Competency 12.10: Differentiate between organic and inorganic fertilizers

Competency Builders:

Identify sources of inorganic fertilizers
Identify sources of organic fertilizers
Identify the main plant nutrients supplied by inorganic and organic fertilizers
Identify multinutrient fertilizers
Explain how plants obtain carbon, oxygen, hydrogen, nitrogen, phosphorus, and potassium
Differentiate between a fertilizer grade and a fertilizer analysis
Explain fertilizer ratio
Explain where most of the nitrogen in the soil is derived
Describe the advantages and disadvantages of dry versus liquid fertilizer
Explain the advantages of foliar fertilization
Identify the factors that influence the efficiency of applied fertilizer such as leaching or fixation

BIL: Recommended – PC, ESA, FWM

EDU:	12	AD
PC		I
ESA	I	R
HS		
ECA		
HM		
WEM		
FWM	I	R
GIS		

Competency 12.11: Describe fertilizer application

Competency Builders:

Explain variable rate fertilization using GPS
Explain the economic factors to consider in buying fertilizers
Describe the methods of applying solid and liquid fertilizers
Explain the purpose of the different placements of fertilizer in the soil, and the relation these placements have to the seed and the growing plant
List the ways fertilizer benefits crop production
Explain how fertilizer applications can decrease crop production
Identify possible losses of each major nutrient and their influences on quality of water in lakes and streams, groundwater quality, and atmospheric quality

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	P
HM		I
WEM	I	P
FWM	I	P
GIS		

Competency 12.12: Explain classification of soil water

Competency Builders:
Compare gravitational, capillary, and hygroscopic water
Demonstrate the water-holding capacities of sandy and clayey soils
Determine soil water availability
List ways available water can be lost by soils
Identify factors in determining water movement in the soil
Explain the main purpose of water conservation
Explain how production techniques influence the efficiency with which water is utilized by plants
Explain water holding capacity and how to determine field soil moisture
Explain the impact of texture and structure on field capacity

BIL: Essential – PC, ESA, WEM, FWM
Recommended - GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	P
GIS	I	R

Competency 12.13: Explain the relationship between soil classifications and land use

Competency Builders:

List the physical features of land and soil necessary for classifying land
Explain the characteristics of each of the land classes
Explain how land capability classes are recorded for use
Explain how topography results from rock type and the opposition of internal and external forces acting on the land surface
Construct a simple topographic map from a three-dimensional model
Demonstrate how chemical and physical weathering work together
Explain how soil relates to the weathering process
Differentiate among topsoil, subsoil, and parent (weathered) rock
Explain permeability
Differentiate between permeability and porosity
Identify the equipment needed to classify soils
Identify the management practices followed to obtain maximum yields and proper soil conservation
Differentiate among different solid structures and textures
Differentiate between erosion and weathering
Describe the role of gravity as the force behind erosion
Explain how vegetation and type of rock affect weathering rate
Identify the agents of erosion, their relative effect, and action to gravity
Explain why and how glaciers move
List evidences of glaciation
Explain why water is the principal agent of erosion
Explain how slope and velocity increase the rate of erosion
Identify landforms that will result from stream action, (e.g., deltas, meanders, flood plains, oxbow lake, cut bank, sand bars)
Explain how forces within the earth cause uplift or mountain building
Explain folding

Differentiate among normal, reverse, and horizontal faults
Explain plate tectonics (cause) and continental drift (effect)
Explain convection currents
Explain how the occurrence of faults relates to earthquakes
Explain how seismographs record earthquakes
Differentiate between the focus and the epicenter
Explain tsunami
Describe how use of land is affected by soil depth, texture, permeability, slope, surface drainage, and degree of erosion
Differentiate among types of water erosion
Explain why soil erosion is very important to land evaluation
Describe the major types of erosion
Identify the factors that influence erosion of soil
Evaluate the effectiveness of erosion prevention procedures
Evaluate land use for construction purposes

Unit 13: Hydrology

BIL: Essential – PC, ESA, HM, WEM, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS	I	P

Competency 13.1: Explain hydrology

Competency Builders:

Describe the hydrologic cycle
Differentiate between the surface hydrologic system and the subsurface hydrologic system
Explain the role of a hydrologist and a hydrogeologist
Identify terminology used in groundwater hydrology
Explain watersheds in relationship to groundwater table
Describe the basic concepts of flow of groundwater in various well models
Identify geologic conditions for determining the potential groundwater supply in various lithologic settings

BIL: Essential – PC, ESA, HM, WEM
Recommended – ECA, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM	I	P
WEM	I	P
FWM	I	R
GIS	I	R

Competency 13.2: Explain geologic and meteorologic principles affecting groundwater supply

Competency Builders:

Explain evaporation, transpiration, and evaportranspiration
Describe the relationship between precipitation and aquifer recharge
Determine basic rock type of drill cuttings and their relative importance to groundwater potential
Determine the porosity of unconsolidated sediment in relation to grain size, grain distribution and composition
Determine relative permeability of unconsolidated sediment
Explain the relationship between specific retention and the specific yield of various rock types and characteristics
Calculate the basic hydraulics involved with groundwater flow including velocity, hydraulic head, and potential flow
Describe the basic concepts of flow of groundwater in various well models
Identify geologic conditions for determining the potential groundwater supply in various lithologic settings

BIL: Essential – ESA, WEM
Recommended – PC, ECA, HM, FWM, GIS

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		I
HM	I	R
WEM	I	P
FWM		I
GIS		I

Competency 13.3: Conduct channel flow analysis

Competency Builders:
Identify open channel flow equipment
Measure open channel flow
Characterize open channel flow
Calculate open channel flow

BIL: Essential - ESA
Recommended – PC, ECA, HM, WEM, GIS

EDU:	12	AD
PC		I
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		I

Competency 13.4: Identify basic criteria for water well design

Competency Builders:
Identify various forms of well records
Determine subsurface structure and flow patterns
Describe basic methods of drilling
Differentiate between production, injection, and monitoring wells
Describe a basic water well system for production, injection, and monitoring
Identify applicable regulations/permit procedures
Identify well development requirements
Identify problems that may develop over the lifetime of a well
Identify well performance characteristics (e.g., flow rate, draw down)
Identify aquifer characteristics that may affect performance

BIL: Essential – PC, ESA, WEM
Recommended – ECA, GIS

EDU:	**12**	**AD**
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		I

Competency 13.5: Identify differences in groundwater potential

Competency Builders:
Identify various geologic regions in the state
Describe the occurrences of groundwater in these geologic settings
Identify important aquifers in these geologic settings
Identify groundwater regions of the United States
Identify important aquifers in the United States

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – FWM, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	P
HM	I	P
WEM	I	P
FWM		I
GIS		I

Competency 13.6: Identify environmental hazards associated with groundwater supplies

Competency Builders:

Describe standard water quality tests
Identify various sources of contamination
Identify methods of restoration of groundwater supplies
Explain water law
Explain the environmental policies regarding groundwater supplies
Identify elements necessary for developing a study of potential groundwater contamination

Unit 14: Pollution Control I

BIL: Essential – PC, ESA, ECA
Recommended – HS, WEM, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM		I
FWM		I
GIS		

Competency 14.1: Identify presence of pollution

Competency Builders:
Evaluate complaints
Verify complaints
Determine extent of hazard
Prioritize complaints
Determine jurisdictions
Monitor instrumentation
Photograph and/or video site
Analyze data
Interpret results
Report violations

BIL: Essential – PC, ESA, ECA
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	E
ECA	I	P
HM		
WEM		I
FWM		
GIS		

Competency 14.2: Perform environmental sampling

Competency Builders:
Make and record observations
Conduct interviews
Identify sampling instruments
Identify appropriate sampling protocols
Calibrate sampling instruments
Take readings
Determine sample types
Identify sampling containers
Take samples
Preserve samples
Analyze samples
Complete chain of custody

BIL: Essential – PC, ESA
Recommended – ECA, WEM

EDU:	12	AD
PC	I	P
ESA		P
HS		
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 14.3: Describe environmental impact from industrial and non-industrial processes

Competency Builders:

Compare input flow vs output and waste stream flows from industrial as well as non-industrial (agricultural) processes
Identify pollution prevention applications
Describe environmental economic impact statements for an industrial process

Unit 15: Pollution Control II

BIL: Essential – PC, ECA, HM
Recommended – ESA, HS, WEM

EDU:	**12**	**AD**
PC	I	P
ESA		I
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		I
GIS		

Competency 15.1: Manage pollution

Competency Builders:
Determine applicable regulations
Control emissions and discharges from sources
Install containment barriers
Reroute source
Implement corrective actions
Implement contingency plan
Monitor levels of pollution
Develop episode control plan

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 15.2: Quantify extent of pollution

Competency Builders:
Conduct field survey
Determine sampling points
Determine threat to public health and safety
Sketch site
Notify appropriate officials/agencies/personnel
Initiate further studies
Develop episode control plan

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 15.3: Locate sources of pollution

Competency Builders:
Plan search activities
Examine documentation history
Conduct search activities
Take measurements [R-HS]
Sample for source of pollution
Conduct mechanical tests
Correct mechanical defects

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 15.4: Monitor remediation activities

Competency Builders:
Describe procedure for monitoring pollution abatement at the source
Describe methods for monitoring magnitude of pollution [R-HS]
Describe procedure for monitoring clean-up [R-HS]
Assess impact of the event
Monitor the pollution abatement

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS, WEM

EDU:	12	AD
PC	I	P
ESA	I	R
HS	I	R
ECA	I	R
HM	I	R
WEM		I
FWM		
GIS		

Competency 15.5: Conduct Remediation Activities

Competency Builders:
Initiate pollution abatement at the source
Investigate alternative technologies
Recommend methods of cleanup
Participate in the implementation of the remediation activity

BIL: Essential – PC, ECA, WEM
Recommended – HM

EDU:	12	AD
PC	I	P
ESA		
HS		
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 15.6: Establish pollution management and prevention program [E-PC]

Competency Builders:
Determine possible sources of pollution
Assess liability of possible pollution sources
Establish purchasing policies
Assess material substitution
Assess incoming materials
Develop proper handling procedures
Communicate importance of RRR (reduce, reuse, and recycle)
Participate in pollution prevention pledge program
Recommend/implement process modifications
Eliminate cross media (pollution) transfer
Assess research needs and pending legislation

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 15.7: Monitor ground and surface water pollution

Competency Builders:
Describe aquatic biological systems
Identify types and sources of water contamination
Collect water samples for analysis
Measure water samples for pH, chloride, turbidity, dissolved solids, biotoxicity, and dissolved oxygen
Investigate watershed boundaries and drainage patterns
Monitor water levels of rivers, streams, ponds and lakes
Identify non-point source hazards
Identify accepted water quality standards for effluent
Demonstrate the technology applied to non-point source pollution control (e.g., stormwater and agriculture runoff)
Monitor water quality (in/out)
Monitor water use (in/out)
Determine water conservation options
Implement water conservation strategies
Analyze water samples
Assess treatment options
Explain impact of exotic species and other growth organisms
Monitor water temperature
Monitor receiving water impacts
Describe legal aspects and consequences of water pollution

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 15.8: Monitor air pollution

Competency Builders:

List the regulated parameters identified industrial source emissions
Describe air pollution control devices used to control emissions of sulfur oxides, nitrogen oxides, particulates and volatile organic contaminants
Measure the air pollutant of a specific source
Interpret laboratory analyses
Explain exhaust system maintenance
Operate IH monitoring equipment
Explain air make-up system maintenance
Maintain controls to minimize odor
Measure vibration levels
Measure source air emission quality
Calculate dispersion and emission rates
Control fugitive emissions
Assess pollution control system
Advise engineering design of air pollution systems
Identify off-property environmental impact
Interpret meteorological data

BIL: Essential – PC, HS, ECA
Recommended – ESA

EDU:	12	AD
PC	I	P
ESA	I	R
HS	I	P
ECA	I	P
HM		
WEM		
FWM		
GIS		

Competency 15.9: Monitor noise pollution

Competency Builders:
Identify the physical properties of sound
Describe the threshold of hearing, tolerance, and hearing loss
Describe environmental noise
Analyze legal aspects and consequences of noise pollution
List sources of noise pollution
List the control devices for different noise sources
Measure noise levels

BIL: Essential – HS, ECA, HM
Recommended – PC, ESA

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	P
ECA	I	P
HM		P
WEM		
FWM		
GIS		

Competency 15.10: Monitor radioactive contamination

Competency Builders:
Describe radiation and radioactive decay
Identify types and sources of radiation, including radon
Describe radiation exposure and dosimetry experiments
Describe immediate and long range effects of radiation on plants and animals
Explain nuclear power hazards and safety features
Describe legal aspects and consequences of radioactive pollution
Measure radioactivity
Use radioactive measurement equipment
Identify certifications required for handling radioactive materials

Unit 16: Chemical Technology

BIL: Essential – PC, ESA, HS, ECA, HM, WEM
Recommended - FWM

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS		

Competency 16.1: Explain basic chemistry principles

Competency Builders:

Explain and describe the properties of matter
Explain chemical terms (e.g., elements, molecules, chemical reactions, bonding, compounds, mixtures)
Describe the organization of the periodic table
Diagram a model of an atom labeling the protons, neutrons, and electrons and their charges
Explain how atoms combine to form molecules
Differentiate among isotopes
Identify the properties of a mixture
Describe solutions and suspensions
Predict the number of different substances in a mixture
Differentiate among acids, bases, minerals, and salts
Differentiate organic and inorganic material
Identify chemical processes and procedures that are controlled or monitored
Describe chemical equations
Explain basic material balancing including the effects of chemical concentrations and solutions
Calculate the amounts of reactants and products in a process reaction (using stoichiometry)
Explain how process variables and catalysts can affect reaction rates
Explain how process variables affect equilibrium reactions
Differentiate between a physical change and a chemical change

BIL: Essential – PC, ESA, ECA, HM, WEM
Recommended – HS, FWM

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	R
ECA	P	R
HM	P	R
WEM	I	P
FWM		I
GIS		

Competency 16.2: Apply chemical laboratory skills

Competency Builders:

Identify chemical abbreviations (e.g., English and AIUPAC)
Interpret chemical equations and specifications
Analyze graphs and charts
Describe common chemical laboratory equipment
Identify safety supplies appropriate to task
Operate safety equipment
Handle hazardous reagents, hot materials, sharp objects, and contaminating materials
Wear appropriate safety clothing
Identify appropriate glassware for task
Weigh chemical reagents to prepare solutions or stains
Mix chemicals to prepare reagents, solutions or stains
Store prepared solutions and stains to maintain optimal condition
Measure pH electronically and manually
Employ extraction procedures on organic analytes
Filter substances to obtain residues
Describe typical laboratory procedures (e.g., heating, cooling, filtration, glassware set-up, distillation, weighing, measuring, pipetting, volumetrics)
Calibrate containers, flasks, balances, safety testing equipment
Clean and decontaminate work areas
Respond to a laboratory spill
Practice safe and proper use of equipment
Identify storage containers that are compatible with the materials to be stored
Mix acids and bases with other materials
Clean with solvents, acids, and detergents
Demonstrate proper titration techniques
Care for desiccators and centrifuges

Describe the physical and chemical properties of common materials and implications for storage
Prepare dilutions in (grams, milligrams, molarity, normality, and ratios)
Set up vacuum and pressure transfer system
Transfer liquids, solids, and gases
Prepare solutions
Obtain representative samples
Maintain electrodes
Change pressurized cylinders
Demonstrate the proper use of pressurized cylinders

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	**12**	**AD**
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	I	P
FWM		
GIS		

Competency 16.3: Calculate and measure in the laboratory

Competency Builders:
Calculate quantities needed to perform a test analysis
Measure volume of a solution to perform a laboratory test
Measure temperatures
Calculate unit conversions
Calculate concentrations
Measure using MKS system
Calculate linear regression curves
Plot calibration curve

BIL: Essential – PC, ESA, ECA, WEM
Recommended – HS, HM

EDU:	12	AD
PC	P	R
ESA	I	P
HS	I	R
ECA	P	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 16.4: Maintain laboratory equipment and supplies

Competency Builders:
Wash laboratory equipment
Sterilize equipment to decontaminate soiled materials
Inventory supplies and equipment
Prepare equipment for tests
Demonstrate procedures to ensure optimal working condition of equipment and devices
Demonstrate procedures to ensure optimal shelf life of chemicals
Demonstrate procedures to ensure safe storage of chemicals

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA	I	P
HM	I	R
WEM		P
FWM		
GIS		

Competency 16.5: Analyze air, water, and solids in the field

Competency Builders:
Monitor stack and fugitive emissions
Sample gases
Analyze gases
Describe pollution control practices
Describe measurements of flow rates
Operate hand-held gas monitor
Monitor and sample wastewater influent and effluent
Analyze physical properties of solids and liquids

BIL: Essential – ESA
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 16.6: Design experiments

Competency Builders:
Conduct on-line literature search
Identify resources (e.g., people, equipment, chemical, and methods)
Gather chemicals and resources
Create a statistical design for the experiment using a quality model
Design control ranges
Write procedures
Design and run computer simulations

BIL: Essential – ESA
Recommended – PC, ECA, HM

EDU:	**12**	**AD**
PC	I	R
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 16.7: Implement new experiment methods

Competency Builders:
Verify method's compliance with regulations
Initialize automated experiments
Monitor automated experiments
Evaluate results
Present results
Assess and redesign experiments as necessary
Implement results as appropriate
Create and report conclusions or final results
Document all phases of the work

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	P	R
ESA	I	P
HS	P	R
ECA	I	P
HM	I	P
WEM	I	P
FWM		
GIS		

Competency 16.8: Handle chemical materials in accordance with standard safety practices

Competency Builders:

Prepare materials for testing and analysis

Describe the characteristics of chemical materials that are applicable to storage and handling (e.g., toxicity, health effects, flammability, reactivity, sensitivity, stability, and compatibility with other materials)

Classify organic and inorganic compounds

Write generalized formulas

Write the symbols for the elements

Describe the characteristics of the common groupings of elements

Describe the basic reactions that occur between commonly used chemical compounds

Complete the proper paperwork associated with receiving materials

Transfer materials to storage or processing units

Identify containers

Prepare and store samples and materials

BIL: Essential – PC, ESA, ECA, WEM
Recommended – HS, HM

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 16.9: **Conduct physical tests: temperature, solids to moisture, paint filter, residual solids, layers, color, odor, vapor pressure, viscosity, slump, and flash/flammability tests**

Competency Builders:
Obtain representative samples
Prepare samples for tests or analyses
Choose appropriate test equipment to make a required measurement
Check instruments for correct operation
Prepare or acquire calibration standards
Calibrate equipment
Test or analyze control "standard" samples
Calculate results and compare with control values
Analyze samples within statistical range,
Troubleshoot causes of error by repeating calibration and instrument check
Record and report data
Clean and maintain apparatus
Characterize the physical properties of gases, liquids, and solids and describe their reactions to changes of temperature and pressure
Identify appropriate equipment for measuring major physical properties based on specified accuracy and precision requirements
Apply ASTM and/or other standard procedures for specific chemical and physical tests
Collect samples to represent bulk materials to be characterized by physical tests
Develop control charts and determine upper and lower control limits for each

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 16.10: Perform chemical analysis

Competency Builders:
Obtain representative samples
Record characteristics
Respond to problems by reading test documents or procedures and implementing appropriate information
Identify the appropriate equipment for the analysis to be conducted
Gather and clean the necessary glassware, reagents, and chemicals
Calibrate the electrodes and other equipment required to carry out the specified analysis
Prepare and standardize reagents
Analyze standards or control samples using specified techniques
Analyze sample
Calculate results to appropriate significant figures
Present results for single samples and to display trends
Evaluate analytical results and respond appropriately
Identify conditions that indicate need for an analysis to be repeated
Report data
Modify or develop analytical methods to be appropriate to necessary test methods, required analyses, implementing personnel qualifications, and working environment where methods are to be used
Select the proper procedure to sample a bulk material
Prepare samples for analysis, including digesting, ashing, extracting, dissolving, grinding, and removing impurities as appropriate prior to analysis
Use standard separation techniques such as ion exchange and column chromatography
Describe the principles and applications of volumetric analysis
Balance chemical equations involving acid/base, redox, and other chemical reactions
Describe the use of pH in characterizing chemical systems

Measure pH using both wet and instrumental methods
Calculate normality, gram equivalents, molarity, and molality of solutions
Describe the characteristics of acids and bases and the chemistry
Describe the chemical, thermodynamic, and chemical kinetic characteristics of materials that can undergo oxidation/reduction reactions
Standardize acid and base solutions of different concentrations (e.g., molarity, molality)
Apply chemistry concepts to measurements
Conduct analytical tests using acid/base titrations, filtrations, and oxidation/reduction titrations.
Apply Beer's law for calculating results
Describe techniques and instruments used for colorimetric analysis
Identify the techniques and devices appropriate for specific samples and accuracy requirements
Describe the principles of gravimetric analysis, and the tools used to conduct such analyses
Describe the processes of filtration and the effect of the filtering medium on the results
Describe the use of several electrochemical techniques
Apply specified information in standard procedural manuals and books, including those produced by ASTM, SM, SW846, NIOSH (McCaww EPA 600), AOAC, 40 CFR Part 60 other groups that produce "standards", and government agencies that issue and/or monitor regulations
Perform extraction techniques including TCLP

BIL: Essential – ESA
Recommended – PC, ECA, HM

EDU:	12	AD
PC		I
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 16.11: Discuss methods to analyze unknown materials

Competency Builders:
Identify interfering materials
Modify analytical procedures
Develop new procedures for chemical analysis

BIL: Essential – ESA, ECA, HM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 16.12: Explain basic organic and inorganic chemistry principles

Competency Builders:
Explain molecular structure in terms of chemical bonding
Explain stoichiometric relations to chemical equations
Write formulas of identified compounds from their names and vice versa
Explain the principles of Charles', Boyle's, Graham's and Dalton's laws
Classify compounds into appropriate groups based on their properties
Explain quantitative relationships to express solution concentrations
Identify organic compounds through the interpretation of IR, mass spectroscopy and gas chromatography

Unit 17: Environmental Instrumentation

BIL: Essential – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM	I	
FWM		
GIS		

Competency 17.1: **Operate basic laboratory equipment and environment monitoring instruments (e.g., pH meter/ISE meter, compound microscope/dissecting microscope, sound level measuring devices, turbidimeter, conductivity meter, chlorine meter OVA, HNMU)**

Competency Builders:
Prepare sample appropriately (e.g., use oil immersion lens, Bunsen/Fisher burner, balance, centrifuge, timing device autoclaves, hot air oven desiccators)
Select appropriate calibration method
Select appropriate calibration standards
Zero the instrument
Span the instrument
Measure samples
Record and store data

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	**12**	**AD**
PC		I
ESA	I	P
HS		
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 17.2: Perform chemical laboratory sample preparation

Competency Builders:
Perform chemical extractions
Perform gravimetric analysis
Perform wet chemical analysis including filtering, distilling, and titrating
Record anomalies
Calculate statistical uncertainties and deviations

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.3: Explain the use of chemical analytic instruments

Competency Builders:

Identify the analytical applications of mass spectrometers, chromatographs, spectrometers
Introduce prepared gas or liquid samples into chromatographs
Obtain quantitative chemical results

BIL: Essential – ESA

EDU:	12	AD
PC		
ESA		P
HS		
ECA		
HM		
WEM		
FWM		
GIS		

Competency 17.4: Perform analytical separation techniques

Competency Builders:

Describe the principles of gas chromatography and typical instrumentation
Separate mixtures of different materials
Describe the principles of liquid chromatography and typical HPLC instrumentation
Calibrate, operate, troubleshoot, and maintain apparatus and instruments
Describe principles of I.C.

BIL: Essential – ESA
Recommended – PC, ECA, HM, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		I
HM		I
WEM		I
FWM		
GIS		

Competency 17.5: Perform spectroscopic analysis using instruments such as: spectrophotometer/auto spectrophometer, AA/graphite furnace, ICP, GC/MS, oxygen meter, IC, IR, FTIR X-ray diffraction nitrogen analyzer, mercury analyzer, FID/PID analyzer, and RAD meter

Competency Builders:
Describe the principles of spectroscopy (e.g., AA, IR, MS, UVIS)
Describe the instrumentation for AA, IR, MS, UVIS
Calibrate, operate, troubleshoot, and maintain spectroscopic instruments
Describe similarities and differences among the various instruments

BIL: Essential – ESA
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 17.6: **Operate advanced laboratory and field equipment and instruments (e.g., HPLC, GC, bomb calorimeter, geiger mueller counter, explosimeters specific gas meters, carbon analyzer, microwave)**

Competency Builders:
Prepare sample appropriately (e.g., use oil immersion lens, Bunsen/Fisher burner, balance, centrifuge, timing device autoclaves, hot air oven desiccators)
Select appropriate calibration method and standards
Zero and span the instrument
Measure samples
Record and store data
Make back-up copies of data
Demonstrate appropriate shut-down procedures

BIL: Essential – ESA
Recommended – PC, ECA, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS		
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 17.7: **Use computers to interface with chemical analytical instruments**

Competency Builders:
Explain how instrument output is collected and stored by the computer
Collect and store data
Manipulate and recall stored data from analytical instrument operations
Create graphs and data tables using computer applications prepared for chemical analysis instruments
Operate chromatographs, mass spectrometers, and electron microscopes using a computer interface
Use computers to determine instrument status and to troubleshoot chemical analytical instruments

BIL: Essential – ESA
Recommended – PC, HS, ECA

EDU:	**12**	**AD**
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.8: Maintain instruments using gas systems

Competency Builders:
Change gas cylinder
Troubleshoot instruments
Start systems after unplanned and planned down time
Discuss use of diagrams to troubleshoot
Bring vacuum systems up and take vacuum systems down
Maintain maintenance and use logs
Maintain gas systems, including plumbing lines, reattaching regulators
Identify regulators and pressures

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.9: Calibrate chemical analytical instruments

Competency Builders:

Adjust filament voltages to tune mass spectrometers
Introduce standard compounds into gas chromatographs and change columns as needed to calibrate chromatograph
Run computer checks, components checks, and system checks
Adjust apertures and beam widths
Identify various deuterated solvents, and their chemical shifts
Recognize "spinning side bands" and ferromagnetic impurities
Run quality control samples

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.10: Operate mass spectrometers

Competency Builders:

Prepare samples for introduction into a mass spectrometer
Introduce samples into a mass spectrometer
Obtain mass spectra of specific compounds using a mass spectrometer as a single instrument or as part of a gas chromatograph, ion trap chromatograph, or inductively coupled argon plasma system
Calibrate mass spectrometers using appropriate calibration standards and by adjusting filament voltage
Clean the ion source
Maintain a mass spectrometer
Troubleshoot a mass spectrometer as a single instrument or as part of a gas chromatograph, ion trap chromatograph, or inductively coupled argon plasma system
Describe the abilities and limitations of chromatographs
Describe the physics of mass spectrometry
Perform spectral interpretation
Describe the relationships between thin layer, column, paper, gas chromatograph, ion chromatograph, supercritical fluid chromatograph

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.11: Operate chromatographs

Competency Builders:

Prepare samples for introduction into a chromatograph
Inject samples into a chromatograph
Calibrate a chromatograph using appropriate calibration standards and by cleaning or changing columns
Maintain a chromatograph, including changing cryogenic gas cylinders
Troubleshoot a chromatograph
Describe the capabilities and limitations of chromatography
Describe the physics of chromatography

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.12: Operate electron microscopes

Competency Builders:

Prepare samples for introduction into an electron microscope
Introduce samples into an electron microscope, including closing and opening the electron gun, emptying and restoring vacuum, and placing the sample
Obtain magnified images of organic and inorganic samples
Obtain elemental analysis of the surface of samples using an energy dispersive system coupled to an electron microscope
Adjust aperture, beam width, voltage, and current to obtain optimum image resolution
Calibrate an electron microscope and energy dispersive system
Maintain an electron microscope and energy dispersive system, including gas fills
Troubleshoot an electron microscope and energy dispersive system
Describe the mechanics of the electrongun, the vacuum system, and the sample stage
Describe the physics of electron microscopy for image magnification and energy dispersion for elemental analysis
Describe the relationships between resolution and aperture, beam width, voltage, magnifications, and current

BIL: Essential – ESA
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.13: Interpret quantitative and graphic output from chemical analysis instruments

Competency Builders:

Identify elements and/or chemical compounds present in a sample from graphic output
Identify relative concentrations of chemical elements and/or compounds present in a sample from graphic output
Quantify results of chemical analyses using numerical output
Record deviations and anomalies (interferents)
Write reports

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	**12**	**AD**
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 17.14: Perform instrumental analysis

Competency Builders:

- Obtain representative samples
- Determine appropriate treatment of the sample prior to conducting an analysis
- Prepare a sample for analysis
- Identify the analytical instrument to be used as appropriate to the results needed and other constraints
- Start up instrument by checking all connections, gas cylinders, and implementing procedures to ensure reliable results
- Set all the instrumental parameters properly using manual and/or program microprocessor settings
- Calibrate and standardize equipment and materials
- Develop necessary calibration charts
- Analyze standards and control materials
- Evaluate results of testing or analyzing standards and control materials
- Readjust operating parameters as necessary
- Conduct analyses
- Review and interpret results
- Record results
- Report results as appropriate
- Perform routine maintenance
- Shut down instrument
- Clean up work area
- Maintain and/or order spare parts necessary to ensure consistent operation

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	**12**	**AD**
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 17.15: Operate and maintain flow instrument systems

Competency Builders:
Identify flow measuring sensors
Explain flow measuring principles
Identify instrument calibration standard units
Analyze systems using troubleshooting flow sheet
Identify displacement measurement methods
Identify the properties of fluid flow measurement
Identify primary and secondary measuring devices for fluid flow
Identify applications for variable area instruments
Identify open channel flow devices
Identify applications for positive displacement meters, turbine flow meters, magnetic flow meters, ultrasonic flow meters
Identify solid particle flow metering methods
Install flow instruments
Identify control valves
Identify control element applications

BIL: Essential – ESA
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 17.16: Operate and maintain pressure test instruments (e.g., manometers, vaccum pumps, pressure and vacuum gages)

Competency Builders:
Identify pressure measuring sensors
Explain pressure measuring principles
Identify instrument calibration standard units
Analyze systems using troubleshooting flow sheet
Identify pressure principles
Install, maintain, and service pressure instruments
Identify force, stress, and strain measurement units
Identify weight and mass measuring instruments
Identify pneumatic and hydraulic actuators
Identify applications of vacuum measuring methods

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.17: Service thermal measuring instruments

Competency Builders:
Identify temperature measuring sensors
Explain temperature measuring principles
Determine temperature measuring instrument and sensor failures
Troubleshoot temperature measuring instruments and sensors
Remove and replace temperature measuring instrument and sensor components
Check and make adjustments to temperature measuring instruments and sensors
Determine calorific value measuring instrument failures
Troubleshoot calorific value measuring instrument
Remove and replace calorific value measuring instrument components
Check and make minor adjustments to calorific value measuring instruments
Identify and explain bimetallic and fluid-filled temperature measuring instruments
Identify instruments that use electrical methods of measuring temperature
Identify pyrometers
Install temperature measuring instruments

BIL: Recommended – PC, ESA, ECA

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.18: Service physical property (sample control) measuring instruments

Competency Builders:
Identify physical property measuring instruments
Explain the principles of physical property measuring instruments
Identify instrument calibration standard units
Analyze systems using troubleshooting flow sheet
Identify level measurement instruments
Identify electrial methods for level measurement
Maintain and service level measuring instruments
Identify final control elements in process loops
Identify on-site safety standards and maintenance practices
Describe electrical and electronic servicing stations
Describe troubleshooting requirements
Troubleshoot and repair density and specific gravity measuring instruments
Check operating systems
Adjust density and specific gravity measuring instruments
Troubleshoot and repair humidity measuring instruments
Check humidity measuring instruments operating systems
Adjust humidity measuring instruments
Troubleshoot and repair moisture content measuring instruments
Check systems moisture content measuring instruments
Adjust systems moisture content measuring instruments
Troubleshoot and repair viscosity measuring instruments
Check viscosity measuring instruments
Adjust viscosity measuring instruments

BIL: Recommended – PC, ESA, HS, ECA

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 17.19: Service chemical property measuring instruments (e.g., O2 meter, spectrophotometer, atomic absorption spectrophotometer inductively coupled plasma, ion chromatography, infrared)

Competency Builders:

Troubleshoot and maintain analytical measuring instruments
Perform operating systems checks and make minor adjustments to analytical measuring instruments
Troubleshoot and maintain pH measuring instruments
Check and make minor adjustments to pH measuring instruments
Troubleshoot and maintain liquid conductivity measuring instruments
Check and make adjustments to liquid conductivity measuring instruments
Troubleshoot and maintain chromatograph measuring instruments
Check and make minor adjustments to chromatograph measuring instruments
Troubleshoot and maintain mass spectrometer measuring instruments
Check and make adjustments to mass spectrometer measuring instruments
Troubleshoot and maintain gas analyzer measuring instruments

Unit 18: Process Technology

BIL: Essential – PC
Recommended – ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 18.1: Operate and control continuous processes

Competency Builders:

Describe the characteristics of a continuous process
Describe the major industrial continuous processes, by (1) describing the characteristics of each, (2) the chemical/physical properties of materials important to the operation, (3) the environmental regulations and safety concerns that are related to each operation, and (4) how the operations usually are interrelated
Interpret process diagrams
Describe the various components and streams of a continuous process
Describe the types and operations of control loops and sample collection devices
Identify typical valves, pumps, and other equipment
Draw a simplified process diagram
Check equipment to ensure safety for electrical loading, physical stressing, and temperature variation
Start up continuous process according to specified procedures
Review checklists associated with a continuous process
Complete required reports to describe process activities, discrepancies, and maintenance
Adjust control equipment as specified by procedures
Set operating parameters
Identify abnormal conditions that require reporting
Record operating parameter information from gauges, instruments, and meters
Adjust operating parameters to optimize conditions
Correct deviations
Respond to alarms
Collect appropriate samples
Conduct on-site inspections

Submit samples for analysis
Record data
Report data
Shut down continuous processes
Shut down continuous processes in emergency situations
Maintain piping networks
Write documentation for an operating procedure
Describe a troubleshooting strategy for a continuous process in upset conditions
Describe the operation, characteristics, and limitations of process measurement equipment (e.g., thermocouples)
Describe process flows (both gas and liquid streams)
Describe the concepts associated with process optimization
Describe when, where, and why samples are taken for analysis and how sampling techniques relate to quality products

BIL: Essential – PC
Recommended – ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 18.2: Operate and control batch processes

Competency Builders:

Describe the characteristics of a batch process
Check equipment safety for electrical loading, physical stressing, and temperature variation
Start up batch processes
Review checklists associated with a batch process
Complete required reports to describe process activities, discrepancies, and maintenance
Adjust control equipment as specified by procedures
Set operating parameters
Identify abnormal conditions that require reporting
Measure raw materials
Explain disposition of "off–spec" batch
Monitor operating parameters by recording information from gauges, instruments, and meters,
Adjust pumps and valves
Adjust operating parameters to optimize conditions
Correct deviations
Respond to alarms
Collect appropriate samples
Conduct on-site inspections
Submit samples for analysis
Record data
Report data
Shut down processes according to procedures
Start up after an emergency shutdown
Describe the major industrial batch processes including common chemical, refinery, water, and waste treatment processes by (1) describing the operation of each; (2) characterizing the chemical/physical properties of

materials that are important to the processes; (3) writing the molecular formulas and chemical structures for substances involved in the processes; (4) describing the chemical reactions involved in each process; (5) describing the chemical equilibrium, kinetics, and chemical reactivity relationships that characterize the processes or may impact safety; and (6) identifying relevant environmental regulations and safety concerns

Read process diagrams

Describe the various components and streams of a batch process

Describe the types and operations of control loops and sample collection devices

Identify typical valves, pumps, and other equipment

Draw a simplified process diagram

Write documentation for an operating procedure that meets regulatory requirements

Describe a troubleshooting strategy for a batch process given a variety of upset conditions

Describe the operation, characteristics, and limitations of process measurement equipment (e.g., thermocouples)

Start up and shut down different kinds of electric motors

Describe the concepts associated with process optimization

Demonstrate ability to add solids, liquids, and gases

Describe the relationship of vacuum and pressure upon boiling point

Operate various types of heat exchangers

Perform filtrations, extractions, distillations, drying, blending, milling, and packaging

Retrieve data and information

Provide shift transfer notes

BIL: Essential – PC
Recommended – ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 18.3: Analyze materials

Competency Builders:

Collect appropriate samples for analysis from process streams or products (solids/liquids/gases)
Inspect samples visually to ensure adequate representation of the sampled materials
Determine response is required
Label samples
Deliver samples
Prepare necessary reagents and standards required to conduct tests
Identify quality control standards and appropriate precision levels
Perform appropriate physical and chemical tests
Calculate results
Determine if resampling and reanalyzing are necessary
Maintain analysis area to ensure correct results will be produced repeatedly
Report results to appropriate personnel
Adjust process parameters as necessary
Enter data into appropriate logs
Review trends of process variations and sample analyses
Compare sample analyses with control values
Submit samples to the laboratory
Characterize gases, liquids, and solids
Obtain representative samples of solids
Describe sampling devices for use with gases under pressure
Use typical sampling devices
Sample a flowing liquid stream
Identify proper containers for a variety of solids, liquids, and gases with a wide range of physical properties
Identify common and standard chemical names
Use standard labeling procedures

Calibrate and measure pH
Explain standard measurement and analytical procedures (e.g., ASTM, AOAC)
Calculate normality, molality, and molarity
Prepare standard solutions
Describe physical properties and measurement methods of materials (e.g., specific gravity, density, flash point, and viscosity
Conduct chemical analyses using volumetric techniques (e.g., acid-base titrations, redox titrations)
Explain the use of instrumental methods such as gas chromatography, infrared, basic spectophotometry, and colorimetry
Describe pressure and temperature relationships for all states of matter
Balance simple chemical equations

BIL: Essential – PC
Recommended – WEM

EDU:	**12**	**AD**
PC		P
ESA		
HS		
ECA		
HM		
WEM		I
FWM		
GIS		

Competency 18.4: Program programmable logic controllers (PLC's)

Competency Builders:
Interpret ladder logic
Identify troubleshooting procedures
Develop process program
Evaluate data generated
Identify trends

Unit 19: Electrical Basics

BIL: Essential – PC
Recommended – ESA, HS

EDU:	12	AD
PC	I	P
ESA	I	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 19.1: Explain electrical concepts

Competency Builders:

Describe the relationship of basic atomic structure to electricity
Describe the relationship between electrical and magnetic properties
Describe the electrical and magnetic properties of a magnet
Describe the photoelectric effect
Describe the thermocouple effect
Describe the electrical effect of friction
Identify sources of electricity
Explain Ohm's Law
Explain Kirchoff's Laws
Identify power formulas
Describe effects varying degrees of electricity have on the human body

BIL: Essential – PC, ESA
Recommended - HS, ECA

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 19.2: Maintain basic electrical systems

Competency Builders:
Replace electrical cords
Replace batteries
Replace fuse(s)
Replace switches and other sensors
Replace plugs
Maintain lockout/tagout

BIL: Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 19.3: Explain DC circuit principles

Competency Builders:

Identify characteristics common to most conductors
Identify materials that can be used as insulators
Identify conductors of electricity
Explain the purpose of insulating material around electrical wiring
Identify different situations where insulation can be employed other than around electrical wiring
Measure resistance and current of conductors and insulators
Measure properties of a circuit using volt-ohm meter (VOM) and digital volt-ohm meter (DVM) meters
Build series, parallel, and combination circuits
Measure current, voltage, and resistance in DC circuits
Explain DC generator action
Explain DC motor action
Identify classes, voltage ratings and/or polarity of electronic components
Identify use of circuit protective devices (e.g., fuses, breakers)
Apply Ohm's Law
Solve problems in electrical units utilizing metric units
Describe the principles and operation of electrochemical supplies
Apply Kirchoff's law
Measure properties of a circuit using analog and digital meters

BIL: Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 19.4: Explain AC circuit principles

Competency Builders:

Analyze properties of an AC signal
Describe principles and operation of characteristics of sinusoidal and non-sinusoidal wave forms
Identify AC sources
Describe principles and operation of characteristics of capacitive circuits
Demonstrate the operation of capacitive circuits
Operate capacitive circuits
Describe principles and operation of characteristics of inductive circuits
Demonstrate the operation of inductive circuits
Operate inductive circuits
Describe principles and operation of the principles of transformers
Analyze power in AC circuits
Measure power in AC circuits
Identify use of circuit protective devices (e.g., fuses, breakers)
Describe basic motor theory and operation
Describe basic generator theory and operation
Measure current, voltage, and resistance in AC circuits
Calculate power factor in AC circuits

Unit 20: Equipment Operation & Maintenance

BIL: Essential – WEM, FWM
Recommended – ESA,HS, GIS

EDU:	12	AD
PC		
ESA		I
HS		I
ECA		
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 20.1: **Operate vehicles (pickup trucks, four-wheel-drive vehicles, tractors, vehicles with attachments, rig-up trucks, graders, backhoe tractors, front-end loaders, excavators, scrappers, cranes, and watercraft)**

Competency Builders:
Explain the safety features of the vehicle
Perform a safety inspection on the vehicle
Drive vehicle
Demonstrate defensive vehicle operation
Back vehicle with attachments into confined space
Control vehicle equipment
Explain procedures for transporting hazardous materials in appropriate vehicles
Interpret operator's and manufacturer's manuals

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA, HM, FWM

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA		I
HM		I
WEM	I	P
FWM		I
GIS		

Competency 20.2: Operate applicable pumps (diesel and gas engines, centrifugal pumps, positive displacement pumps, air and gas compressors)

Competency Builders:
Follow appropriate safety precautions
Prime pump when appropriate
Start the pump
Adjust the flow rate
Shut pump down

BIL: Recommended – PC, HS, HM, WEM, FWM

EDU:	12	AD
PC		I
ESA		
HS		I
ECA		
HM		I
WEM		I
FWM		I
GIS		

Competency 20.3: Operate applicable miscellaneous equipment (hoists, winches, pulleys, boilers and associated equipment, drilling equipment)

Competency Builders:
Identify function of equipment
Follow appropriate safety precautions
Set up equipment
Use equipment for desired purpose
Shut down equipment

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA	I	R
HS	I	R
ECA		I
HM		I
WEM	I	R
FWM	I	R
GIS	I	R

Competency 20.4: **Operate applicable electronic equipment (electrical distribution systems, electronic survey equipment, generators)**

Competency Builders:
Identify health hazards
Describe safety practices
Identify source of electricity
Set up electrical equipment
Lay electrical cords within safety standards
Conduct survey
Monitor generator
Shut down electronic system

BIL: Essential – ECA
Recommended – PC, ESA, HS, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	P
HM		I
WEM	I	R
FWM	I	R
GIS		I

Competency 20.5: **Maintain a preventive maintenance schedule**

Competency Builders:

Observe and record any deviations from normal operations
Initiate work requests
Implement a preventive maintenance schedule
Inspect equipment
Prepare equipment for maintenance
Set up a maintenance schedule
Open lines and equipment
Change seals and valves on on-line equipment
Change seals and packing on pumps and valves
Change and replace pipes
Check fluid levels in process equipment
Conduct vibrational analysis
Conduct steam tracing techniques
Test and replace pressure release valves
Check standards
Complete maintenance logbooks
Complete calibration records/logbooks
Reference O & M (Operations and Maintenance) manuals

BIL: Essential – ECA, HM, FWM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA		
HS	I	R
ECA		P
HM		P
WEM	I	R
FWM	I	P
GIS		

Competency 20.6: Maintain equipment according to owners' manual specification

Competency Builders:
Add lubricant and fuel
Analyze engine performance
Make necessary adjustments to engine
Check and adjust tire air pressure
Inspect and service battery
Inspect and service/replace spark plugs
Inspect and service/replace air cleaners
Check and refer for service thermostats, fans, and radiators
Inspect and refer for service water pumps, lines, and connections
Perform seasonal service on cooling systems
Conduct voltage, current, resistance, charging and load tests
Clean, repair, and paint

Unit 21: Hydraulics & Pneumatics

BIL: Essential – ECA, WEM
Recommended – PC, HS

EDU:	12	AD
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 21.1: Describe fluid flow concepts

Competency Builders:
Explain Pascal's Law
Explain Boyle's Law
Explain Bernoulli's Principle
Describe flow velocity
Explain how heat and pressure relate to power and transmission
Describe physical and chemical properties of a fluid
Describe fluids in motion in closed conductors
Describe continuity of mass flow
Identify types of fluids
Identify properties of fluids
Identify English and metric units of measurement for pressure, density, and viscosity

BIL: Essential – ECA, WEM
Recommended – PC, HS

EDU:	12	AD
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 21.2: Describe energy considerations

Competency Builders:

Differentiate work and power
Differentiate potential and kinetic energy
Explain energy conservation concept
Explain hydraulic horsepower
Explain work of compression in compressible fluids

BIL: Essential – WEM
Recommended – PC, ECA

EDU:	12	AD
PC		I
ESA		
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 21.3: Describe system losses

Competency Builders:
Differentiate turbulent and laminar flow
Explain Manning's formula for friction
Explain friction factor
Explain pressure losses
Identify potential system losses (e.g., leaks, wear, component sizing, heat, dirt)

BIL: Essential – ECA, WEM
Recommended – PC, HS

EDU:	**12**	**AD**
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 21.4: Describe hydrostatics

Competency Builders:
Explain pressure, density, and viscosity
Explain buoyancy
Explain equilibrium

BIL: Essential – WEM
Recommended – PC

EDU:	12	AD
PC		I
ESA		
HS		
ECA		
HM		
WEM		P
FWM		
GIS		

Competency 21.5: Calculate energy

Competency Builders:
Explain application of Pascal's Law in energy calculation
Explain application of Bernoulli's Principle in energy calculation
Explain application of Boyle's Law in energy calcuation
Calculate work and power
Calculate potential and kinetic energy
Calculate hydraulic horsepower
Calculate flow velocity and pressure
Calculate pressure losses
Calculate laminar flow
Calculate pump capacity
Calculate system requirements

BIL: Essential – WEM
Recommended – PC, HS. ECA

EDU:	12	AD
PC		I
ESA		
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 21.6: Describe hydraulic component operation

Competency Builders:

- Identify functions and operation of hydraulic components
- Identify functions and operation of pneumatic components
- Explain application(s) of different materials (e.g., plastic, copper, PVC, CPT)

BIL: Essential – WEM
Recommended – PC, ECA, FWM

EDU:	**12**	**AD**
PC		I
ESA		
HS		
ECA		I
HM		
WEM		P
FWM		I
GIS		

Competency 21.7: Assess pipe flow characteristics

Competency Builders:
Determine head and pressure and loss
Determine weir flow
Determine full flow
Determine pressure flow
Determine friction loss
Determine gravity flow
Determine cubic feet per second (CFS)
Determine wing walls
Determine stability and capacity

209

BIL: Recommended – PC, ECA, WEM, FWM

EDU:	**12**	**AD**
PC		I
ESA		
HS		
ECA		I
HM		
WEM		I
FWM		I
GIS		

Competency 21.8: **Maintain piping and accessories for high and low pressure fluid power systems**

Competency Builders:

Identify components of a piping system
Explain maintenance features of both metallic and non-metallic piping systems
Explain types of valves and their operation and maintenance
Explain use and maintenance of strainers, filters, and traps in piping systems
Join common fittings
Join pipe
Join copper and steel tubing
Bend copper and steel tubing
Cut copper and steel tubing
Flare tubing

BIL: Recommended- PC, ECA, WEM

EDU:	12	AD
PC		I
ESA		
HS		
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 21.9: Maintain and repair pump

Competency Builders:
Identify types and operating features of pumps
Identify pump capacity and system requirements
Explain packing and seal requirements
Explain operating principles of pumps (e.g., centrifugal, propeller and turbine rotary, metering)
Disassemble pumps
Reassemble pumps
Perform shaft alignment

Unit 22: Surveying & Mapping

BIL: Essential – PC, FWM, GIS
Recommended – ESA, ECA, HM, WEM

EDU:	12	AD
PC		P
ESA	I	R
HS		
ECA		I
HM	I	R
WEM	I	R
FWM	I	P
GIS	I	P

Competency 22.1: Identify civil drafting symbols and abbreviations

Competency Builders:
Identify standard symbols and abbreviations
Set up a map legend
Locate symbols and features on a U.S.G.S. map
List common types of symbols used in civil drafting
Identify abbreviations for words commonly used in civil drafting
Identify factors that determine when an abbreviation should be used
State purposes of symbols on maps
Draw examples of north arrow symbols
Describe general rules for drawing map symbols
Describe methods used in drawing symbols
Match color codes with corresponding map symbols
Identify common material symbols used in structural and architectural drawings
Identify common welding symbols

BIL: Essential – PC, ESA, ECA, HM, FWM, GIS
Recommended - WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	P
HM	I	P
WEM	I	R
FWM	I	P
GIS	I	P

Competency 22.2: Read maps

Competency Builders:
Identify major classes of maps
Explain terms related to map scales and measurement
Create chart of standard measures and their equivalents
Identify characteristics of map scales
Describe ways map scales are expressed
Identify ranges of map scales and their classifications
Identify factors affecting the selection of a map scale
Match types of maps with their common scales
Identify characteristics of a quadrangle scale
Match quadrangle scales commonly used on U.S.G.S. topographic maps with their one-inch equivalencies
Identify characteristics of graphic scales
Explain published map accuracy standards
Describe types of scales used in civil drafting
Convert a representative fraction to a graphic scale
Read a vernier scale
Measure with a civil engineer's scale
Measure acreage on maps
Differentiate between latitude and longitude

BIL: Essential – FWM, GIS
Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM	I	P
GIS		P

Competency 22.3: Utilize surveying skills

Competency Builders:
Describe survey methods used to determine distances and positions of points
Identify types of horizontal and vertical angles
Explain stationing
Explain purpose of field notes
Describe the arrangement of field notes in the field book
Identify types of field notes
Record field notes
Explain traverses
Differentiate between a bearing and an azimuth
Convert azimuths to bearings and bearings to azimuths
Describe common methods for plotting traverses

BIL: Essential – GIS
Recommended – ESA, ECA, HM, WEM, FWM

EDU:	12	AD
PC		
ESA		I
HS		
ECA	I	
HM	I	R
WEM		I
FWM	I	P
GIS	I	P

Competency 22.4: Perform site measurements

Competency Builders:
Determine location and distance from maps
Identify major parts of a compass
Read a compass
Sight along a given bearing
Describe compass declination and variation
Explain surveying [R-HM]
Differentiate among accidental and systematic errors and mistakes
Explain use of principal surveying equipment
Describe types of surveys and their uses [R-HM]
Measure distance in field [R-HM]
Measure area in field [R-HM]
Measure elevations in field [R-HM]
Reference datum [R-HM]
Pace horizontal distance [R-HM]
Tape horizontal distance [R-HM]
Explain differential leveling [R-HM]
Explain profile leveling
Explain cross-sectional leveling
Measure horizontal angles
Measure vertical angles
Use planimeter [R-HM]
Compare microcomputer surveying and mapping application programs
Apply GPS technology in surveying [R-HM]

BIL: Essential – GIS
Recommended – PC, ECA, FWM

EDU:	12	AD
PC		I
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS	I	P

Competency 22.5: Draft maps

Competency Builders:
Explain terms related to map drafting procedures
Identify characteristics of drafting media
List types of lettering used in civil drafting
Identify rules for good lettering
Differentiate among map registration methods
Describe reprographic techniques used in civil drafting
Identify types of pressure-sensitive films
Describe methods used for coloring maps
Describe aerial photography
Interpret aerial photographs and maps
Record measurements on photos or in records
Describe the standard sheet format for a set of civil drawings
Label components of a map layout
Identify the steps for drafting a map or drawing
Make rough tracings of maps
Describe common mistakes made in map drafting
Differentiate among types of planimeters
Label the parts of a polar planimeter
Produce finished map of area
Identify underground surveying techniques
Ink a mapped area
Apply transfer film and press-on letters
Register a map

BIL: Essential – GIS
Recommended – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

Competency 22.6: Prepare topographic maps

Competency Builders:
Explain how elevation is shown on a topographic map
List uses of topographic maps
Describe types of surveys used in topographic mapping
Identify field methods for obtaining topography
Identify factors affecting the selection of the field method to be used for a topographic survey
Differentiate between horizontal and vertical controls for topographic surveys
Lay out a topographic survey
Determine topography
Describe methods used to establish contours
Identify national standards for horizontal and vertical accuracy on topographic maps
Create a chart of scale ratios used in the USGS topographic series
Describe the selection of contour intervals
Identify characteristics of contour lines
Match contour line features with their correct configurations
Identify common methods used to calculate area from a topographic map
Calculate cut and fill using the contour area method
Plot a profile from profile leveling notes
Develop a profile from a contour map
List three methods for plotting contours lines
Explain how to fix a grade line
Describe aerial photogrammetry
Identify advantages and disadvantages of using aerial photography for mapping
Identify applications of aerial photogrammetry
Explain aerial photo control
Interpolate contours from a grid survey

217

Prepare profiles from the contour map
Set up contours in isometric
Calculate grades in percents

BIL: Recommended – GIS

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

Competency 22.7: Map transportation system

Competency Builders:

State the purpose of route surveys
Describe the fundamentals of a route survey
Describe superelevated roadways
Identify elements of a horizontal circular curve
Explain mathematical formulas used for computing a horizontal curve
Describe circular curve layout by tangent offsets
Describe vertical curves
Describe plan views for route surveys
Identify characteristics of profiles for a route survey
Identify characteristics of cross sections for a route survey
Describe field note reduction for a cross section
Explain plotting cross sections
Differentiate among methods used to determine areas of cross sections
Identify formulas for calculating earth volume
List drawings included in a set of highway plans
Identify common horizontal and vertical scales used in transportation mapping
List items that appear on a typical title sheet for a set of highway plans
Describe detail sheets
Draft plan views, profiles, and cross sections
Layout open traverses
Layout a survey alignment for a road
Plot field notes for horizontal control, topography, profile, and cross section for a proposed road

BIL: Essential – GIS
Recommended – HM, WEM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM	I	R
WEM		I
FWM		
GIS	I	P

Competency 22.8: Map municipal infrastructure

Competency Builders:

Explain terms related to municipal mapping
Identify types of utilities
List agencies who develop and maintain municipal maps
Identify users of municipal maps
Describe types of drawings used in municipal mapping
Describe methods of presenting utilities on maps
Describe the surveying and mapping of municipal maps
List support information needed to develop utility drawings
Explain utility easements
Identify types of valves and valve housings
Identify types of gas piping and devices
List information included on utility drawings
Describe types of sewers and sewer lines
Research the plats for local utilities

Unit 23: Drafting Technology

BIL: Essential – PC, GIS
Recommended – ECA, WEM, FWM

EDU:	12	AD
PC	I	P
ESA		
HS		
ECA		I
HM		
WEM		I
FWM		I
GIS	I	P

Competency 23.1: Apply basic drafting skills

Competency Builders:
Identify line styles, weights (alphabet of lines)
Select proper drawing scale, introduction to different types
Prepare title blocks and other drafting formats
Apply freehand and other lettering techniques
Develop multi-view drawings
Develop multi-view sketches
Develop orthographic views
Develop change control block
Describe change control block/revision block
Measure angles
Draw horizontal, vertical, angular, parallel, and perpendicular lines
Transfer an angle
Construct tangent lines (to arcs) and tangent arcs (to arcs)
Bisect angles and arcs
Bisect lines
Divide lines
Construct three-point circle
Construct regular hexagon, pentagon, and octagon
Reproduce a drawing
Develop single-view drawings
Develop dimension drawings
Interpret notes and dimensions to determine part
Draw arcs, circles, and conics
Transfer measurements

BIL: Essential – GIS
Recommended – PC, ECA, FWM

EDU:	12	AD
PC	I	R
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS		P

Competency 23.2: Prepare drawings

Competency Builders:
Describe types of blueprints and their applications
Demonstrate isometric, oblique and perspective sketching techniques
Prepare isometric, oblique and perspective sketches
Prepare sectional views
Prepare auxiliary views
Identify ANSI symbols
Describe systems drafting techniques
Dimension drawings using ANSI$_y$ 14.5 standards
Describe purpose of auxiliary and sectional views
Prepare pictorial drawings
Prepare schematics
Draw conics
Interpret basic pneumatic/hydraulic standard and symbols

BIL: Essential – GIS
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC		I
ESA		
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		P

Competency 23.3: Interpret machine, hydraulic and pneumatic, instrument, electrical, process flow, P & ID diagrams, and detail and assembly drawings/prints/schematics

Competency Builders:

Identify the types of information found on floor plans, elevation plans, flow diagrams, piping and instrumentation diagrams, and electrical diagrams
Identify commonly used symbols and abbreviations
Explain how to trace diagrams
Explain how to use diagrams to locate actual components
Visualize object from drawing
Analyze orthographic projections
Analyze isometric views
Analyze sectional views
Explain dimensions
Explain tolerances
Identify GD&T symbols
Identify basic mechanical standards and symbols

BIL: Essential – GIS
Recommended – PC, ECA, FWM

EDU:	12	AD
PC		I
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS		P

Competency 23.4: Analyze structural drawings

Competency Builders:
Explain structural drawing
List types of structures
Identify types of materials used for structures
Describe types of steel members
Identify structural steel shapes
Explain drawing practices for steel members
Describe the placement of gage lines for steel members
Describe fastener sizes and spacings
Explain dimensioning procedures for steel structures
Label a structural steel callout
Explain structural steel marking
Describe anchor bolts
Differentiate among types of concrete
Identify types of concrete reinforcement
Identify standard pre-stressed concrete units
Describe foundation parts
Describe types of structural drawings for concrete
Create chart of symbols and abbreviations for concrete placing drawings
Identify standard practices for documentation of rebar
Identify typical details of concrete structures
Describe wood construction
Identify types of wood connectors
Identify types of framing connectors
Describe components of wood construction
Explain heavy timber construction
Prepare detail drawings of structural steel members
Draw to scale a concrete engineering drawing
Detail a wood truss

BIL: Recommended – PC, ECA, GIS

EDU:	12	AD
PC	I	R
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS	I	R

Competency 23.5: Demonstrate dimensioning techniques

Competency Builders:

Convert dimensions and tolerances to and from metric to English units
Construct arrowheads using various styles/disciplines
Apply symbols for surface and texture control
Add labels/notes to drawing
Interpret decimal tolerance dimensions
Prepare dimensional drawing of arcs, angles, curves, rounded-end shapes, spherical objects, cylindrical objects, cones, pyramids, prisms, features on circular center line, theoretical point of intersection, object using rectangular coordinate system, object using polar coordinate system, object using tabular coordinate system, object using ordinate dimensioning system

Unit 24: CADD Fundamentals

BIL: Essential – PC, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC		P
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS	I	P

Competency 24.1: Identify computer mapping applications

Competency Builders:
Classify hardware used in a CAD system as input, output, or neither
Explain data input
List types of data output
Differentiate between digital and interactive computer graphics
Identify types of computer drawings
List methods of storing graphic information
List advantages of using computers for mapping applications
Describe an interactive data management system for mapping

BIL: Essential – PC, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC		P
ESA		
HS		
ECA		I
HM		
WEM		
FWM		I
GIS	I	P

Competency 24.2: Operate a CADD system

Competency Builders:
Boot system/start up procedure
Log on terminal
Load start file
Use keyboard input
Use screen and tablet menus
Use other input devices (e.g., scanner, digitizer)
Create scaled plots
Operate a pen plotter
Operate a printer-plotter (i.e., laser plotter)
Access on-line help for commands
Convert files
Transfer data
Manage files
Plot out drawings
Store a file
Shut down a system
Log off

BIL: Essential – PC, GIS
Recommended – FWM

EDU:	12	AD
PC		P
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

Competency 24.3: Change existing drawings or details

Competency Builders:
Plan drawing changes
Find drawing file
Load drawing file
Execute changes
Obtain approvals/check drawing changes
Plot out drawing
Update file

BIL: Essential – PC, GIS
Recommended – FWM

EDU:	**12**	**AD**
PC		P
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

Competency 24.4: Compose drawings

Competency Builders:
Plan original drawing
Employ system commands
Manipulate geometry
Select geometry
Add test
Rotate views
Move views
Scale views
Dimension a drawing
Store files

BIL: Essential – GIS
Recommended – PC, FWM

EDU:	12	AD
PC		I
ESA		
HS		
ECA		
HM		
WEM		
FWM		I
GIS	I	P

Competency 24.5: Create 2-D orthographic drawings

Competency Builders:
Create primitive drawing entities
Draw utilizing absolute Cartesian coordinates
Draw utilizing relative Cartesian coordinates
Draw utilizing polar coordinates
Draw using construction aides (e.g., snaps, grid, snap)
Change drawing attributes
Edit drawing entity properties (e.g., color, layer, thickness, linetype)
Construct drawing entities (e.g., offset, timer, extend, break, mirror)
Edit drawing entities
Set system variables (e.g., units, scale)
Annotate orthographic drawings
Create layers
Identify layers
Manipulate layers
Save files
Create back-ups
Create hatches, patterns, symbols
Recall drawing templates/blocks
Create text styles
Edit text styles
Select text styles
Apply notes
Create dimensions
Edit text
Control dimension variables/models
Apply view control while drawing (e.g., zoom and pan)
Control view resolution (e.g., viewers)
Save views

Display views
Add or remove entities separately
Add or remove entities using a window
Add or remove entities with a crossing-box
Select entities using a fence
Select entities by other methods (e.g., last, previous, type)

BIL: Essential – PC, GIS
Recommended – ECA, FWM

EDU:	12	AD
PC		P
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM		I
GIS	I	P

Competency 24.6: Extract entity and drawing information

Competency Builders:
Measure distances
Measure areas
Identify locations
List entity characteristics (e.g., length, size, location, properties, etc.)

Unit 25: Waste Management

BIL: Essential – PC, ESA, HM
Recommended – HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

Competency 25.1: Collect waste materials

Competency Builders:
Identify source of waste materials
Monitor collection of waste materials
Document collection of waste materials
Determine sampling method
Prepare sampling container
Collect sample
Prepare chain of custody
Test waste materials
Document waste materials testing
Identify hazardous materials/waste
Determine compatibility of waste materials
Separate waste materials
Identify container type
Contain waste materials
Label waste materials
Review waste material labels
Document contained-waste collection
Identify regulations

233

BIL: Essential – PC, ESA
Recommended – ECA, HM

EDU:	12	AD
PC	I	P
ESA		P
HS		
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 25.2: Treat waste materials

Competency Builders:
Separate waste materials
Verify operating parameters
Determine test method
Add additional chemicals to material
Monitor efficiency of additions
Document compliance with treatment standards
Document raw-materials usage
Maintain inventory of supplies
Sort treated materials
Release treated materials
Seek markets for recovered materials
Match recovered materials with end users
Identify regulations

BIL: Essential – PC, ESA, HM
Recommended – HS, ECA

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA		IR
HM	I	P
WEM		
FWM		
GIS		

Competency 25.3: Manage waste

Competency Builders:
Monitor instrumentation
Determine material needs
Verify the operation of the equipment
Reroute source
Troubleshoot equipment
Identify source of waste materials
Document contained-waste collection
Identify hazardous materials
Determine compatibility of waste materials
Separate waste materials
Contain waste materials
Label waste materials
Document contained-waste collection
Store material containers
Load/unload storage containers
Transport waste materials
Repair leaking containers
Clean up container leaks
Verify operating parameters
Determine test method
Add additional chemicals to material
Monitor efficiency of additions
Document raw-materials usage
Sort treated materials
Initiate pollution abatement at the source
Document non-reusables
Monitor pollution abatement at the source
Determine disposal method

Identify container for non-reusables
Label non-reusables
Monitor clean-up
Arrange for transportation of non-reusables
Sample waste before disposal
Transport non-reusable
Monitor disposal by contractor
Dispose of non-reusables
Destroy non-reusables
Perform routine maintenance on implements
Perform routine maintenance on test instruments
Remove trash

BIL: Essential – PC, HM
Recommended – ESA, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		I
HS		
ECA	I	R
HM	I	P
WEM		I
FWM		
GIS		

Competency 25.4: Manage waste systems

Competency Builders:
Develop waste system training
Coordinate mandatory consultation programs
Manage and implement three R's program (i.e., reduce, recycle, reuse)
Characterize all waste
Register subject waste
Arrange waste collection
Arrange waste disposal
Prepare manifest for subject waste
Conduct waste audits including compliance and pollution prevention components
Establish waste reduction work plans
Manage internal waste disposal operations
Monitor leachate collection systems
Process leachate
Assess leachate treatment options

BIL: Essential – PC, ESA, ECA
Recommended - HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	P
HM	I	R
WEM		
FWM		
GIS		

Competency 25.5: Identify characteristics of solid waste treatment

Competency Builders:

Explain solid waste
List sources of solid waste
Identify types of solid waste
Identify physical and chemical compositions of waste
Correlate typical source with locations and type of solid waste
Describe landfill alternatives (reduction, separation, processing, waste of energy and application)
Describe characteristics of a sanitary landfill
List reactions that occur as a landfill matures

BIL: Essential – PC, ESA
Recommended – ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 25.6: **Identify the risks associated with solid waste accumulation and disposal**

Competency Builders:
Describe the composition, sources, and quantity of solid waste
Describe methods of solid waste disposal
Describe various solutions to solid waste accumulations and disposal
Describe the legal aspects and consequences of solid waste pollution
Describe the construction features of a safe landfill
Describe the possibilities of contaminates (leachates) seeping into the groundwater
Describe the need to have monitoring wells located around a sanitary landfill
Identify those wastes that are permitted by state and federal regulation to be disposed at a landfill site

BIL: Recommended – PC, ESA, ECA, HM

EDU:	12	AD
PC		I
ESA	I	R
HS		
ECA	I	R
HM	I	R
WEM		
FWM		
GIS		

Competency 25.7: Describe methods of site identification and acceptance

Competency Builders:

List typical factors that may restrict or eliminate a potential location from consideration as a future landfill site
Develop a plan to identify and manage the parts of the waste stream
List factors that determine waste acceptability
Identify liquids that may be excluded from landfill
Describe management options for lead acid batteries, used oil, eludes and infectious waste
Identify radioactive waste
Describe operational/equipment limitations that would prevent materials from going into landfills and disposal options

BIL: Essential – PC, ESA
Recommended – HS, HM

EDU:	12	AD
PC	I	P
ESA	IR	P
HS		I
ECA		
HM	I	R
WEM		
FWM		
GIS		

Competency 25.8: Describe the process of waste decomposition

Competency Builders:

Categorize waste by method of decomposition and by-products created
List factors that effect the rate of decomposition
List events that occur in a landfill as a result of decomposition
Explain subsidence
Explain differential settlement
Describe settlement control
Identify methods to determine whether settlement is occurring
Explain landfill gas operation [R-HM]
Describe composition of landfill gas and gas generation cycle [R-HM]
Explain landfill gas migration [R-HM]
List items that intercept migration routes [R-HM]
Describe techniques for recognition and control of landfill migration [R-HM]
Explain leacheate generation [R-HM]
Characterize leacheate
Describe leacheate impact [R-HM]
List controlling factors in establishing leacheate quality [R-HM]

BIL: Essential – ESA
Recommended – PC, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 25.9: Describe sanitary landfill procedures

Competency Builders:
Describe aspects of site security
Describe the importance of excluding unacceptable waste from the landfill
Describe the careful execution of a monitoring permit
Identify the size of working at the operations field station
Identify access for vehicles at operations field station
Describe landfill equipment operation
Identify compaction practices at operations field station
Describe scope of work at operations field station
Describe nuisance conditions at operations field station including litter control, odors, and noise
Describe cover at operations field station
Classify field station operation (e.g., daily, intermediate, and final)
Describe drainage control (i.e., run-on, run-off, depressions, erosions) at operations field station
Describe liner integrity at field operations site including vegetation, sand blanket, erosion, waste placement, and traffic
Describe other factors at field operations site including leachate seeps and vegetation screening
List recommended procedures for maintaining monitoring well
Complete chain of custody record for equipment at operations field station
Describe an area of the field operations site that illustrates the best type of soil for different methods of operation
Describe resource recovery and source reduction procedures

BIL: Essential – ESA
Recommended – PC, HS, HM

EDU:	12	AD
PC		I
ESA	IR	P
HS		I
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 25.10: Monitor sanitary landfill procedures

Competency Builders:

Explain safety rules and the importance of each
Identify individual safety items needed for landfill personnel to be appropriately equipped
Identify waste types received at operations field station including liquids, hazardous wastes, special wastes
Obtain samples from monitoring well at field operations site including the purging of a well
Complete laboratory analysis form
List various types of soil and their best use
Operate equipment used in soil sampling
Take a meter reading

BIL: Recommended – PC, ESA, HM

EDU:	12	AD
PC		I
ESA	I	R
HS		
ECA		
HM	I	R
WEM		
FWM		
GIS		

Competency 25.11: Describe methods to operate a composting facility

Competency Builders:
Identify materials acceptable in a compost facility
Describe the steps necessary to construct a facility
Identify procedures used in receiving material
Describe operational procedures
Describe records/management document

BIL: Essential – HM
Recommended – PC, ESA, HS, ECA

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 25.12: Describe methods to incinerate waste

Competency Builders:
Identify materials acceptable to be received at facility
Describe methods employed in incineration of waste
Describe material flow in incinerators
Explain methods employed in separating waste
Identify data management procedures

BIL: Essential – PC, HM
Recommended – ESA, ECA

EDU:	12	AD
PC	I	P
ESA	I	R
HS		
ECA		I
HM	I	P
WEM		
FWM		
GIS		

Competency 25.13: Describe recycling methods

Competency Builders:
Identify materials appropriate to recycle
Describe the economic and physical drivers associated with recycling
Identify methods to receive recycling material
Describe recycling management procedures
Identify markets for recycling material
Identify market factors associated with recycling

BIL: Recommended – PC, ESA, HS, HM, WEM

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA		
HM		I
WEM		I
FWM		
GIS		

Competency 25.14: Explain control processes for landfill gas and leacheate

Competency Builders:

List characteristics of decomposition, leacheate, and landfill gas
Describe process for determining the potential for landfill gas
Describe process for locating test wells
List types of test wells
Describe monitoring process used to detect the presence of methane
Describe control methods for landfill gas
Describe methods for landfill gas recovery and use
Describe process which prevents leacheate contact with groundwater [R-WEM]
Describe control process of surface water [R-WEM]
List characteristics of leacheate migration [R-WEM]
Describe controls for surface discharge of leacheate [R-WEM]
Describe methods for detecting leacheate discharge to groundwater [R-WEM]
List methods for control of leacheate migration [R-WEM]
Describe remedial actions which may be taken where leacheate is contaminating groundwater [R-WEM]
List types of leacheate treatment systems [R-WEM]
Describe methods of leacheate recirculation [R-WEM]
List representative leacheate treatment technologies both biological and physical/chemical and give characteristics of each [R-WEM]
List characteristics of an effective groundwater monitoring program [R-WEM]

BIL: Essential – HM
Recommended – PC, ESA, ECA

EDU:	12	AD
PC		I
ESA		I
HS		
ECA		I
HM	I	P
WEM		
FWM		
GIS		

Competency 25.15: Identify design requirements for sanitary landfills

Competency Builders:
Explain how specifications are used in the construction of landfills
Describe the basic types of plans necessary to show how a facility is to be developed
List items essential to following facility plans
Describe methods of measuring horizontal distance determining compliance with a facility plan

BIL: Recommended – PC, ESA, HS, ECA, HM, WEM

EDU:	12	AD
PC		I
ESA	I	R
HS		I
ECA		I
HM		I
WEM		I
FWM		
GIS		

Competency 25.16: Describe standard operational techniques for sanitary landfills

Competency Builders:

Identify elements that dictate facility operations
Read sanitary landfill plans
Identify elements of a design plan
Identify elements of an operational plan
Identify items an operator must control for a successful operation
List methods for controlling moisture
List methods for controlling run-off
List methods for controlling waste
Explain confinement methods
Explain compaction methods
Explain ratio of slope to compaction in an ideal landfill situation
Describe the advantages of using proper soil for use as cover
Describe types of cover and their functions
Describe operation of a lined sanitary landfill
Describe what must be accomplished to ensure a lined system will function
Identify operational problems that are exacerbated by weather
Identify strategies to resolve weather related problems
Identify hard-to-handle wastes
Describe operational problems exacerbated by hard to handle wastes
Explain how to handle hard-to-handle wastes
Identify failures of site operation principles that could result in environmental and health problems
Identify potential nuisance and health problems
Identify controls that can be used to reduce nuisance and health problems

BIL: Recommended – PC, ESA

EDU:	12	AD
PC		1
ESA		1
HS		
ECA		
HM		
WEM		
FWM		
GIS		

Competency 25.17: Explain sanitary landfill equipment procurement and maintenance

Competency Builders:

Identify types of equipment and their advantages and disadvantages in the operation of a sanitary landfill
Describe daily maintenance of equipment program
Describe shutdown procedures
Describe a periodic maintenance program
Describe the role of accurate records of maintenance in the decision to depreciate and replace equipment
Identify costs that are common to maintain a sanitary landfill
Explain the bid process
List methods of equipment financing
Perform a total cost evaluation (TCE) of equipment considered for purchase or lease-purchase

BIL: Recommended – PC, ESA, ECA

EDU:	**12**	**AD**
PC		I
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 25.18: Describe site closure methods and post-closure considerations

Competency Builders:

Describe goals that must be met for successful site closure
Describe steps in preplanning the closures
Describe the process that should occur three months prior to closure
Describe steps that should occur at closure
Describe things that need to be done three months after closure
Describe landfill gas control systems and their usefulness in long-term maintenance of a closed landfill
Explain use of data gathered from landfill gas and leacheate monitoring systems
Explain how surface water and settlement can effect the containment of waste in a closed landfill
Describe some end uses for closed sites
Describe buffer layer, gas channel, filter layer, barrier, topsoil, and vegetation
Identify guidelines for constructing the final cover system
Identify desirable characteristics for vegetation on final cover
Explain how to determine soil suitability for planting and plant requirements for nutrients
Describe method for planting and protecting the seed
Identify methods for controlling run-on and run-off on a closed site
List information used by inspectors to determine acceptability of closure
Describe methods of financing closure and post closure

Unit 26: Drinking Water Treatment Operations

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM	I	P
FWM		
GIS		

Competency 26.1: Identify characteristics of drinking water treatment

Competency Builders:

Identify constituents inherent to groundwater and/or surface water
Describe the pH scale and its importance in the water-treatment process
Correlate treatment processes to types of facility influent and solids
Identify commonly measured drinking water items
Identify factors affecting raw drinking water
Identify waterborne diseases
Identify gases found in drinking water

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	P	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.2: Sample drinking water

Competency Builders:

Identify the reasons for sampling and the types of samples (e.g., simple, representative, grab, composite)
Describe methods of sample collection and handling
Identify process control samples (biological or chemical)
Identify representative sampling points
Determine the significance of process control sample results (biological or chemical)
Identify the basic procedure for quality control/quality assurance in sampling
Identify the significance of the flow measurement on process control
Identify pathogenic organisms, including bacteria, protozoa, and virus, and describe their disease associations
Identify applicable regulatory sampling guidelines
Test for bacteria
Explain sample chain of custody
Apply correct sample-collection procedures for inorganic and organic analyses
Describe the need for chemical analyses in water treatment
Determine whether the finished water is acceptable or unacceptable

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	P	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.3: Identify constituents of water entering water-treatment facility

Competency Builders:

Differentiate between turbidity and the microbiological quality of raw water
Describe the uses of chemical analysis in water-treatment operations
Identify commonly used units of constituent measurement
Explain the importance of water treatment for the control of coliform bacteria and algae

BIL: Essential – PC, ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM		
WEM		P
FWM		
GIS		

Competency 26.4: Analyze the constituents of drinking water

Competency Builders:

Analyze the specific physical, chemical, and biological characteristics of drinking water

Identify ranges in drinking water treatment and limits on facility discharges

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	R
FWM		
GIS		

Competency 26.5: Explain the aeration process in water treatment

Competency Builders:
Differentiate between aeration and air stripping
Identify types of aeration systems
Explain the benefits of aeration
Describe the components of an air-stripping system
Describe process control methods for aeration systems

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.6: Monitor the mixing, coagulation, and flocculation processes in water treatment

Competency Builders:

Explain turbidity, color, coagulation, and flocculation
Identify the kinds of equipment used in the coagulation process
Identify coagulant chemicals used in water-treatment facilities
Identify the steps of coagulation
Identify specific sampling locations for control in a coagulation process
Identify factors that would contribute to poor floc formation
Compute the feed rate in pounds per day (lbs/d)
Compute the dosage (mg/l) of coagulant
Compute the dosage rate that is needed to treat a different flow (MGD) at the current dosage

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.7: Monitor the filtration and sedimentation process in water treatment process

Competency Builders:

Explain concepts related to filtration including types of filters, filter-system components, and the steps for normal filtration operations
Explain common problems of filtering systems including head loss, mudballs, filter media loss, and blinding
Determine when to backwash a filter
Identify the steps for backwashing a filter
Explain filter backwash rates
Explain concepts of sedimentation, including types of classifiers, sedimentation system components and steps for normal operation
Measure sedimentation rates

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.8: Monitor the water-softening process in water treatment

Competency Builders:
Identify treatment processes used for water softening
Describe types of hardness
Describe alkalinity and its components
Calculate the distribution of bicarbonate, carbonate, and/or hydroxide ions when given the total alkalinity and phenolphtalein alkalinity
Describe carbonate removal
Identify the important zones of an upflow clarifier unit
Identify the appropriate chemical(s) to use in chemical-precipitation softening process
Compute lime demand from raw-water analyses
Describe the reasons for recarbonization
Compute hardness removal when the ion-exchange capacity is known

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.9: Monitor the stabilization process in water treatment

Competency Builders:
Identify the chemicals used in stabilization
Identify two stabilization indices
Conduct marble test
Conduct Langelier index

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	**12**	**AD**
PC		I
ESA	I	P
HS		I
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 26.10: Monitor the corrosion-control process in water treatment

Competency Builders:
Describe problems that can be created by corrosive waters
Describe an electrochemical reaction
Identify the factors that influence corrosion
Explain cathode film formation
Describe the conditions for calcium carbonate film formation
Identify the chemicals used in corrosion control
Describe cathodic protection and its application in water-treatment
Describe the basic concepts of electrolysis
Describe effects of lead and copper rule

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 26.11: Monitor the disinfection process in water treatment

Competency Builders:
Identify chemicals used in primary disinfection
Identify non-chemical methods in primary disinfection
Identify commonly used chlorinators and hypochlorinators
Determine the maximum amount of chlorine gas (in pounds) that may be taken from a cylinder in a 24-hour period
Identify proper maintenance procedures for equipment chlorination
Identify terminology related to chlorination and disinfection
Identify common safety problems or emergency situations that might occur during chlorination
Identify the properties of chlorine and its use in water treatment
Explain the points at which chlorine is applied most effectively in water treatment
Compute the feed rate (lbs/d)
Compute the feed rate (lbs/d) of a hypochlorite compound
Compute the new rate of flow and the feed rate that will be needed to maintain the current dosage
Compute the feed rate needed to treat a given amount of water

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	**12**	**AD**
PC		I
ESA		P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 26.12: Monitor the control and treatment of trihalomethanes in water

Competency Builders:

Describe the formation of total trihalomethanes (TTHM)
Collect samples to determine trihalomethane levels
Compute the quarterly average and the annual TTHM measurements
Identify processes that remove trihalomethane precursors
Identify processes that remove trihalomethanes after they are formed
Identify the benefits of alternate disinfectants
Describe chloramination as a control of TTHM

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.13: Monitor the iron and manganese removal processes in water treatment

Competency Builders:
Describe the importance of controlling iron and manganese
Explain the occurrence of iron and manganese in source water and in treated water
Perform sample-collection and analysis procedures for iron and manganese

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	R
HM		
WEM	I	P
FWM		
GIS		

Competency 26.14: Describe taste and odor control in water treatment

Competency Builders:
Identify common types of complaints about water quality
Identify causes of tastes and odors
Explain how microbial growths affect tastes and odors
Explain how eutrophication contributes to surface-water tastes and odors
Describe a cross-connection
Identify the chemicals used in the control and treatment of tastes and odors
Describe the Threshold Odor Number (TON) test
Determine the TON when dilution volumes and positive samples are given

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC		I
ESA		P
HS		I
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 26.15: Describe the demineralization processes in water treatment

Competency Builders:

Explain concepts related to demineralization (e.g., reverse osmosis (RO), flux, feedwater, permeate, salinity)
Describe the structure, composition, and performance of an RO membrane
Describe feedwater impurities, physical parameters, and conditions potentially harmful to the RO process
Identify items included in a typical RO-facility-operation checklist
Describe the common causes of membrane damage
Describe the procedure for membrane cleaning
Compute the percent of recovery
Compute the percent of mineral rejection
Describe the basic concepts of electrodialysis (ED), such as the cathode and anode relationship and the removal of typical inorganic salts
Describe the most common problem of ED operation in a facility
Explain how the cation membrane and the anion membrane differ
Describe the multi-compartment unit used in the ED process
Describe ED operating procedures in detail
Describe the most common chemical solutions used to flush ED stack membranes

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 26.16: Monitor the fluoridation process in water treatment

Competency Builders:
Identify the basic concepts of fluoridation and the kinds of chemicals used
Identify the properties of fluoride and its use
Identify the types of equipment used in fluoridation
Describe proper maintenance procedures for fluoridation equipment
Describe potential safety problems or emergency situations in the fluoridation process, and ways to avoid them
Compute the feed rate of chemicals used in the fluoridation process

267

BIL: Recommended – PC, ESA, HS, WEM

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		
HM		
WEM		I
FWM		
GIS		

Competency 26.17: Correct facility operational problems in water treatment

Competency Builders:

Describe common facility operational problems in the treatment train, effluent disposal, and solids management
Identify appropriate corrective actions for common problems in disposal, and solids management
Troubleshoot coagulation and flocculation
Troubleshoot sedimentation
Troubleshoot disinfection
Troubleshoot filtration
Troubleshoot corrosion control
Troubleshoot taste and odor control
Troubleshoot iron and manganese control
Troubleshoot fluoridation
Troubleshoot softening
Troubleshoot demineralization
Troubleshoot trihalomethanes

BIL: Essential – PC, ESA, HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS		P
ECA	I	P
HM		
WEM	I	P
FWM		
GIS		

Competency 26.18: Explain state and federal environmental protection agency (EPA) rules for drinking water

Competency Builders:

Describe the operator's duties and responsibilities, certification requirements, testing, renewal, staffing, and facility classification
Complete a EPA monthly operating report (MOR) form
Describe OSHA, EPA, and local health department rules for procedures such as reclaimed water, reuse, and biosolids residuals management
Describe federal rules that apply to the operation of a drinking water-treatment facility

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA

EDU:	12	AD
PC	I	P
ESA	IR	P
HS	I	R
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 26.19: Analyze environmental microbiological techniques

Competency Builders:
Perform coliform analyses
Perform sterilization techniques
Describe cultivation of microorganisms
Perform a standard plate count
Perform pressure presence/absence in membrane filter colifon analysis

BIL: Essential – PC, ESA
Recommended – HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 26.20: Identify methods for backflow prevention

Competency Builders:
Explain cross-connection
Identify purposes and consequences of backflow prevention
Identify approved backflow prevention devices

Unit 27: Wastewater Treatment Operations

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27.1: Identify characteristics of wastewater treatment

Competency Builders:
Identify constituents inherent to groundwater and/or surface water
Describe the pH scale and its importance in the water-treatment process
Correlate treatment processes to types of facility influent and solids
Identify biological organisms used in treatment processes
Identify commonly measured wastewater items
Identify factors affecting raw wastewater
Identify waterborne diseases
Identify gases found in wastewater

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27:2 Sample wastewater

Competency Builders:
Identify the reasons for sampling and the types of samples (e.g., simple, representative, grab, composite)
Describe methods of sample collection and handling
Identify process control samples (biological or chemical)
Identify representative sampling points
Determine the significance of process control sample results (biological or chemical)
Identify the basic procedure for quality control/quality assurance in sampling
Identify the significance of the flow measurement on process control
Identify laboratory tests required by the NPDES permit
Identify pathogenic organisms, including bacteria, protozoa, and virus, and describe their disease associations
Identify regulatory sampling guidelines
Perform coliform analyses
Describe cultivation of microorganisms
Test for bacteria
Explain sample chain of custody
Apply sample-collection procedures for inorganic and organic analyses
Describe the need for chemical analyses in wastewater treatment
Determine whether the finished water is acceptable or unacceptable

BIL: Essential – PC, ESA, ECA, WEM
Recommended - HS, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	R
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27.3: Describe wastewater collection systems

Competency Builders:

Identify types of wastewater collection systems
Identify flow variations and conditions that affect plant treatment including infiltration, inflow, and lift stations
Describe methods to detect and correct infiltration and inflow
Identify dissolved gases in wastewater and the effect of their presence/absence on treatment

BIL: Essential – PC, ESA, ECA
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM		
WEM		
FWM		
GIS		

Competency 27.4: **Identify constituents of wastewater entering wastewater treatment facility**

Competency Builders:

Describe the uses of chemical analysis in wastewater-treatment operations
Identify commonly used units of constituent measurement
Identify pollutants, chemical, and microbial in raw water

BIL: Essential – PC, ESA, ECA, WEM
Recommended –HS, HM

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA	I	P
HM	I	R
WEM	I	P
FWM		
GIS		

Competency 27.5: Analyze the constituents of wastewater

Competency Builders:

Analyze the specific physical, chemical, and biological characteristics of wastewater

Analyze attached and suspended growth, respiration, gas production, aerobic and anaerobic conditions, differences in effluent disposal, and biosolids management

Identify ranges in wastewater treatment and limits on facility discharges

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM	I	P
FWM		
GIS		

Competency 27.6: Troubleshoot collection system

Competency Builders:

Explain the significance of dissolved gases in the influent and the effects of dissolved gases on treatments
Explain the sources of infiltration and inflow and the effects of infiltration and inflow on treatment processes
Detect infiltration and inflow
Correct infiltration and inflow
Explain the effect of lift-station performance on the overall treatment process
Implement solutions for lift-station problems, such as surging flows, septic conditions, and power outages

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 27.7: Describe the mixing, coagulation, and flocculation processes in wastewater treatment

Competency Builders:

Identify coagulant chemicals used in wastewater-treatment facilities
Identify the steps of coagulation
Identify specific sampling locations for control in a coagulation process
Identify factors that would contribute to poor floc formation
Compute the feed rate in pounds per day (lbs/d)
Compute the dosage (mg/l) of coagulant
Compute the dosage rate that is needed to treat a different flow (MGD) at the current dosage

BIL: Essential – ESA
Recommended – PC, HS, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS	I	R
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 27.8: Describe the disinfection process in wastewater treatment

Competency Builders:

Identify chemical disinfection methods
Identify non-chemical disinfection methods
Identify commonly used chlorinators and hypochlorinators
Determine the maximum amount of chlorine gas (in pounds) that may be taken from a cylinder in a 24-hour period [R-HS]
Identify proper maintenance procedures for equipment chlorination
Identify terminology related to chlorination and disinfection [R-HS]
Identify terminology related to ultraviolet disinfection
Identify common safety problems or emergency situations that might occur during chlorination
Identify the properties of chlorine and its use in waste water treatment
Explain the points at which chlorine is applied most effectively in waste water treatment
Compute the feed rate (lbs/d)
Compute the feed rate (lbs/d) of a hypochlorite compound
Compute the new rate of flow and the feed rate that will be needed to maintain the current dosage
Compute the feed rate needed to treat a given amount of water

BIL: Essential – ESA, WEM
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA	I	R
HM	I	R
WEM		P
FWM		
GIS		

Competency 27.9: Describe the treatment train, effluent disposal, and solids management in wastewater

Competency Builders:
Describe concepts related to preliminary and primary treatment
Describe the types of preliminary-treatment equipment, the way they function, and the relationship of each to the treatment train
Describe the types of primary-treatment equipment, the way they function, and the relationship of each to the treatment train
Describe concepts related to secondary treatment, including attached growth, aeration, and clarification
Describe process control methods for aeration systems
Describe the types of secondary-treatment equipment, the way they function, and the relationship of each to the treatment train
Describe concepts related to tertiary-treatment processes, including sand filtration, nitrification/denitrification, oxic/anoxic, activated carbon, and artificial wetlands
Describe the types of tertiary-treatment equipment, the way they function, and the relationship of each to the treatment train
Describe concepts related to disinfection and effluent disposal, including surface water, reuse reclamation, deep well, and ocean outfall
Describe the types of disinfection and the types of effluent-disposal equipment, they way they function, and the relationship of each to the system
Describe concepts related to solids management, including thickening, aerobic and anaerobic digestion, stabilization, dewatering, and reuse
Describe the types of solids-management equipment, the way they function, and the relationship of each to the system

BIL: Essential – ESA, WEM
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		I
WEM		P
FWM		
GIS		

Competency 27.10: Analyze process optimization for the treatment train, effluent disposal, and biosolids management in waste water treatment

Competency Builders:

Interpret laboratory data commonly obtained on incoming wastewater to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for handling influent

Interpret laboratory data commonly obtained on wastewater during primary treatment to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for handling primary treatment

Interpret laboratory data commonly obtained on wastewater during secondary treatment to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for secondary treatment

Interpret laboratory data commonly obtained on wastewater during tertiary treatment to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for tertiary treatment

Interpret laboratory data commonly obtained on reclaimed water during disinfection and disposal to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization for disinfection and disposal processes

Interpret laboratory data commonly obtained during solids management, including solids-content tests, to monitor the efficiency of the identified treatment

Describe possible adjustments to achieve process optimization in solids management

Identify proper disposal of solids based on the analysis of constituents, including accountability records and costs

BIL: Essential – ESA, WEM
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		I
WEM		P
FWM		
GIS		

Competency 27.11: Analyze treatment process control for the treatment train, effluent disposal, and biosolids management in wastewater

Competency Builders:
Describe grit-removal process
Describe laboratory tests performed on influent
Describe primary-clarifier removal efficiencies including settleable solids, suspended solids, total solids, BOD, and bacteria
Describe sampling points, frequency of sampling, and the laboratory tests and results that are used for the proper operation of the primary clarifier
Identify and plot on a trend chart the parameters for primary clarification
Describe advanced laboratory tests takes in the primary sedimentation tank
Evaluate the performance of secondary-treatment processes including attached growth, suspended growth, aeration, and clarification
Describe sampling points, the frequency of sampling, and the laboratory tests and results used for proper operation of the secondary-treatment processes
Identify and plot on a trend chart the parameters for secondary clarification
Describe advanced laboratory tests taken in the secondary-treatment processes
Evaluate the performance of tertiary-treatment processes, including sand filtration, phosphorus removal, and nitrogen removal
Describe sampling points, the frequency of sampling, and the laboratory tests and results used for checking the proper operation of tertiary treatment
Identify and plot on a trend chart the parameters for tertiary treatment
Describe advanced laboratory tests taken in advanced or tertiary treatment
Evaluate the performance of effluent-disposal processes, including disinfection and dechlorination
Describe sampling points, the frequency of sampling, and the laboratory tests used for checking the proper operation of effluent disposal
Identify and plot on a trend chart the parameters for effluent disposal
Describe the chemical and physical properties of chlorine

Describe the reactions of chlorine with water, ammonia compounds, and sulfides
Describe the safe storage and handling of chlorine, including the use of testing compounds
Explain the points of application of chlorine in wastewater treatment
Describe methods of dechlorination
Describe methods commonly used to dispose of wastewater effluents, including reuse applications
Describe laboratory tests commonly used on the reuse of effluent
Describe types of sludge and their characteristics
Evaluate the performance of solids management, including sludge thickening, digestion, dewatering, and disposal processes
Describe sampling points, the frequency of sampling, and the laboratory tests and results used for checking the proper operation of solids management
Describe advanced laboratory tests for disinfection, effluent disposal, and solids management
Identify 503 sludge regulations
Identify various recycling methods

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 27.12: Inspect and maintain equipment for the treatment train, effluent disposal, and biosolids management in wastewater

Competency Builders:

Identify equipment used in the treatment train, effluent disposal, and solids
Identify the maintenance needs of equipment used in the treatment train, effluent disposal, and solids management
Document the results of inspections
Develop preventive maintenance plans for equipment used in preliminary-, primary-, secondary-, and tertiary-treatment processes, and for equipment used in effluent disposal and solids management
Explain trends analysis used in preventive-maintenance planning for all treatment processes, effluent disposal, and solids management
Describe the monitoring of facility-equipment operation and usage with remote sensing equipment

BIL: Essential – ESA, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA		P
HS		
ECA		I
HM		
WEM		P
FWM		
GIS		

Competency 27.13: Describe common facility operational problems

Competency Builders:

Check accuracy of observed operational problems in preliminary, primary, secondary, and tertiary treatment, effluent disposal, and solids management
Identify appropriate corrective actions for common problems in disposal, and solids management
Describe the methods for monitoring results of corrective action taken for common problems in preliminary, primary, secondary, and tertiary treatment, effluent disposal, and solids management
Identify sedimentation problems
Identify disinfection problems
Identify filtration problems

BIL: Essential – PC, ESA, ECA, WEM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA		P
HM		
WEM	I	P
FWM		
GIS		

Competency 27.14: Explain state and federal environmental protection agency (EPA) rules for waste water

Competency Builders:

Describe the operator's duties and responsibilities, certification requirements, testing, renewal, staffing, and facility classification

Explain rules concerning samples and analysis at wastewater-treatment facilities

Complete an EPA monthly operating report (MOR) form

Complete a National Pollution Discharge Elimination System (NPDES) MOR form

Identify OSHA, EPA, and local health department rules for procedures such as reclaimed water, reuse, and biosolids residuals management

Identify federal rules that apply to the operation of a wastewater-treatment facility

BIL: Essential – PC, ESA
Recommended – HS, ECA, WEM

EDU:	12	AD
PC	I	P
ESA		P
HS		I
ECA		I
HM		
WEM		I
FWM		
GIS		

Competency 27.15: Identify methods for cross-connection and backflow prevention

Competency Builders:
Identify purposes and consequences of backflow prevention
Identify approved backflow prevention devices

288

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA, HM

EDU:	12	AD
PC	I	R
ESA		P
HS		I
ECA	I	R
HM	I	R
WEM		P
FWM		
GIS		

Competency 27.16: Identify industrial pretreatment program

Competency Builders:
Identify categorical industries
Identify non-categorical industrial
Identify purpose of industrial pretreatment
Describe federal and state pretreatment regulations

Unit 28: Hazardous Materials Management

BIL: Essential –ESA, ECA, HM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.1: Describe risks related to hazardous materials

Competency Builders:
Define hazardous material
Differentiate hazardous materials incidents from other emergencies (First Responder Awareness-FRA; First Responder Operations Level-FRO; Hazardous Materials Technician-HMT; Hazardous Materials Specialist-HMS)
Differentiate between hazardous materials and waste with non–hazardous materials (FRA, FRO, HMT, HMS)
Differentiate between acute and chronic hazards
Describe the properties /nomenclature of hazardous materials
Describe physical, chemical, biological hazards (including explosion/fire hazards)
Describe the routes of exposure for hazardous materials
Describe the fundamentals of chemical hazards including but not limited to vapor pressure, boiling points, flash points and pH (FRA, FRO, HMT, HMS)
Describe fire and explosion hazards of chemicals including typical ignition sources (FRA, FRO, HMT, HMS)
Describe viral and bacteriological hazards of biological materials
Describe types of radiation and their effects
Identify examples of a confined space
Describe the hazards related to confined space (FRA, FRO, HMT, HMS)
Describe general safety hazards (e.g., electrical hazards, powered equipment hazards motor vehicle hazards, walking-working surface hazards associated with working in hot and cold temperature extremes (FRA, FRO, HMT, HMS)
Identify routes by which hazardous materials enter the human body upon exposure

Describe the basic principles of toxicology
Describe the human signs and symptoms as responses to exposures to chemical, biological and radiological hazards

BIL: Essential – ESA, HS, ECA, HM
Recommended – PC, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.2: Describe health and safety practices to reduce risks from hazardous materials

Competency Builders:

Describe protocol to control stress from noise
Describe the exposure guidelines for hazardous materials (theshold limit value, permissible exposure limits)
Explain the impact of basic nutrition on the risks from hazardous materials
Describe the elements of a spill control program (FRO, HMT)
Describe examples of engineering controls, equipment and safety technology or safety procedures (FRO, HMT)
Identify typical design and construction of containers, bulk and non-bulk packaging used to store , process, or transport hazardous materials (e.g., bags, bottles, boxes, cans, carboys, drums, fixed tanks, intermodel portable taks, piping tank cars, tank trucks, and trailers (FRO, HMT)

BIL: Essential – ESA, HS, ECA, HM
Recommended – PC

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.3: Demonstrate appropriate responses for major types of hazardous materials disasters (e.g., chemical, fire and explosion, general safety hazards) (FRA, FRO, HMT, HMS)

Competency Builders:
Describe the principles and practices of establishing exposure zones, and medical surveillance stations and procedures (HMT, HMS)
Describe how MSDS (material safety data sheet) may be used to obtain hazard and response information
Identify risk assessment considerations of hazardous materials (e.g., size and type of container and quantity involved; nature of the container stress; potential behavior of the container and its contents; level of resources available; exposure potential to people, property, environment, and systems; and weather conditions and terrain) (FRA, FRO, HMT, HMS)
Describe the procedures for implementing continuing response actions consistent with local emergency response plan, the organizations standard operating procedures, and the current edition of Department of Transportations's ERG including extended emergency notification procedures and follow-up communications (FRA, FRO, HMT, HMS)
Demonstrate decontamination procedures
Describe the advantages and limitations of each of the following methods of decontamination: absorption, adsorption, neutralization, and solidification (HMT, HMS)
Identify the steps in critiquing a hazardous materials incident

BIL: Essential –PC, ESA, HS, ECA, HM
Recommended – WEM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.4: Describe appropriate use of Personal Protective Equipment (PPE)

Competency Builders:

Describe the following terms as associated with chemical protective clothing: degradation; penetration; and permeation
Identify the physical and psychological stresses that can affect users of specialized protective clothing
Identify various types of protective breathing apparatus and the advantages and limitations of each at a hazardous materials incident (FRO, HMT, HMS)
Interpret chemical compatibility chart for chemical protective clothing (FRO, HMT, HMS)
Explain the four levels of PPE (A, B, C, D) (FRO, HMT, HMS)
Identify the equipment used with each of the four levels of PPE
Identify the conditions under which it is safe to enter a space with each of the four levels of PPE

BIL: Essential – ESA, ECA, HM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.5: Explain hazardous substance regulations

Competency Builders:

Describe the role of federal, state and local agencies in developing and implementing regulation

Describe the core elements of an occupational safety and health program as identified in 29 CFR1910.120 (q) (FRA, FRO, HMT, HMS)

Describe the components of an effective site safety and health plan consistent with the requirements of 29 CFR1910.120 (b)(4)(ii)

Describe what activities are controlled by OSHA 29 CFR1926 regulations

Describe the record keeping requirements for workmen's compensation, OSHA (100 &200), Department of Transportation, and the Environmental Protection Agency

Explain the rights and responsibilities of employers and employees under applicable OSHA and EPA laws

Describe confined space considerations as outlined in 29 CFR 1910.146 and lock-out tag-out standards

Explain OSHA's hazard-communication standard (29 CFR 1910.1200)

Explain the impact of the following regulations on hazardous substance:
- CERCLA- Comprehensive Environmental Response Liability and Compenstation Act (Super Fund)
- RCRA- Resource Conservation and Recovery Act
- TSCA- Toxic Substance Control Act
- SDWA- Safe Drinking Water Act
- CWA -The Clean Water Act
- CAA- Clean Air Act
- HM181- Hazardous Materials Regulations
- NFPA-704- National Fire Protection Association No. 704
- Code of Federal Regulations
- SARA- Super Fund Amendment and Reauthorization Act

295

Explain the competencies of the First Responder at the Awareness level as covered in the National fire Protection Association Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (FRA)

Explain the competencies of the First Responder at the Operations Level covered in the National Fire Protection Association's Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (FRO)

Explain the competencies of the Hazardous Materials Technician covered in the National Fire Protection Association's Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (HMT)

Explain the competencies of the Off-Site Specialist Employee covered in the National Fire Protection Association's Standard No. 472 Professional Competence of Responders to Hazardous Materials Incident (HMS)

BIL: Essential – ESA, ECA, HM
Recommended – PC, HS, WEM

EDU:	12	AD
PC	I	R
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		I
FWM		
GIS		

Competency 28.6: **Demonstrate an ability to obtain and use information addressing hazardous substance release**

Competency Builders:

Identify chemical reference materials (i.e., NIOSH)
Describe the use of mapping
Identify suppliers and technical resources
Identify responders
Demonstrate competency using the U.S. Department of Transportation's Emergency Response Guidebook (ERG) (FRA, FRO, HMT)
Demonstrate competence using manufacturer material safety data sheets, CHEMTREC//CANUTEC, shipper or manufacturer contacts, and other sources of information addressing hazardous substance release (FRO, HMT)
Demonstrate competence using hazardous materials computer databases and response models (HMT)
Utilize computer networking

BIL: Essential – PC, ESA, ECA, HM
Recommended – HS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.7: Conduct environmental sampling

Competency Builders:
Determine reason for sample
Define risks associated with sampling
Identify sampling protocol
Follow chain of custody procedures
Determine frequency of sampling
Identify testing plan
Define QA/QC protocol
Identify potential sample interferences
Demonstrate preventive maintenance and testing procedures, including operational and calibration checks, for sampling and monitoring equipment
Demonstrate appropriate use of equipment (e.g., bailers, hand augers, organic-vapor analyzers, pumps, radioactivity measuring equipment, split spoons, combustible gas detector, oxygen meter, elorimetric tubes, pH papers and strips, CO meter, radiation detection instruments, colorimetric indicator, combustible-gas indicator, organic-vapor analyzer,OVA, HNU, PID and explosimeter)
Demonstrate container sampling and safeguarding procedures (e.g., general drum/container handling procedures, special requirement for laboratory waste packs, shock-sensitive wastes, and radioactive wastes (HMS)
Sample ground water, waste water, sewer line, drum, air, soil, unknown materials, personnel
Perform field tests (i.e., HAZCAT)
Perform OVD test
Identify proper preservation and storage procedures for hazardous materials samples
Demonstrate the appropriate use of the Perform personnel-exposure monitoring
Follow chain-of-custody procedures

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.8: Demonstrate safe handling procedures for hazardous materials and hazardous waste

Competency Builders:

List and describe containers used to store hazardous chemicals and waste (HMS)

Describe safe handling procedures for hazardous materials

Describe different types of hazardous substance transportation vehicles (HMT)

Demonstrate appropriate selection and use of the various types of equipment available for plugging or patching transportation containers, vessels or vehicles (HMS)

Implement safe chemical-handling procedures (e.g., bonding fire control, grounding, storage, vapor control, ventilation)

Demonstrate safe handling procedures for bulk chemical containers, drums, and portable and stationary tanks (HMT)

Prepare to ship sample to laboratory (per Department of Transportation)

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.9: Demonstrate record keeping

Competency Builders:
Explain why and how long hazardous materials incidents should be documented including training records, exposure records, incident reports, and critique reports
Keep an activity log and exposure records for a hazardous materials incident
Explain the importance of daily record keeping
Keep time sheets
Keep a field diary of sampling activities
Keep inventory records
Prepare chain of custody for sample
Prepare documentation of laboratory results
Prepare documentation of monthly preventive checks and services
Maintain an equipment log
Develop schedules

BIL: Essential – ESA, ECA, HM
Recommended – PC, HS

EDU:	12	AD
PC		I
ESA	I	P
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.10: Evaluate laboratory results

Competency Builders:
List criteria for the selection of the laboratory
Identify laboratory methodology
Identify laboratory instrumentation
Identify laboratory quality control procedures

BIL: Essential – ESA, HS, ECA, HM
Recommended – PC

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.11: Demonstrate health and safety practices to reduce risks from hazardous substances

Competency Builders:
Demonstrate lead and asbestos safety procedures
Demonstrate confined space safety procedures
Demonstrate decontamination procedures
Demonstrate the procedures to carry out a respirator program to comply with 29 CFR 1910.134 (FRO, HMT)
Demonstrate methods of communication including those used while wearing respirator protection
Demonstrate the donning and doffing of protective equipment (FRO, HMT, HMS)
Write a site safety plan
Conduct a site safety meeting
Obtain first aid/CPR certification

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.12: Demonstrate methods for identifying hazardous material

Competency Builders:

Describe the advantages, disadvantages, and limitations of placards, labels, container markings, and shipping papers used in the transportation of hazardous materials

Describe the shipping papers found in various modes of transportation, the individual's responsible for the papers, and location where carried and found during an incident

Explain circumstances for use of the following terms: hazardous substances, hazardous chemicals; extremely hazardous substances; hazardous wastes; hazardous materials; and dangerous goods

List the advantages and disadvantages of each of the following information sources: MSDS; reference guidebooks; hazardous materials data base; technical information centers such as CHEMTREC; technical information specialist; monitoring equipment; and NIOSH pocket guide to chemical hazards

Explain labeling of hazardous materials by the chemical and physical properties of color, corrosivity, density, flammability, reactivity, specific gravity, toxicity, and viscosity

Identify hazardous wastes according acute toxicity, corrosivity, ignitability, reactivity, and toxic characteristic leachate procedure (TCLP)

Demonstrate proper labeling for hazardous wastes

Label containers of repackaged materials with appropriate warnings and expiration information

BIL: Essential – ESA, HS, ECA, HM
Recommended – PC

EDU:	12	AD
PC	I	R
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.13: Detect hazardous materials

Detect toxicity, flammability, reactivity, radioactivity, corrosively, and oxygen deficiency
Use MSDS in obtaining hazard and response information to determine isolation and evacuation distances
Use air reactivity; catalysts and inhibitors; concentration; corrosivity; critical temperature and pressure; instability; oxidation ability; pH; polymerization; radioactivity; self-accelerating decomposition temperature (SADT); strength; sublimation; surface tension; viscosity; volatility; and water reactivity in the risk assessment process
Explain the use of threshold limit value (TLV-TWA); lethal concentration and dose (LD 50/100); parts per million/billion (ppm/ppb); immediately dangerous to life and health (IDLH); permissible exposure limit (PEL); short-term exposure limit (TLV-STEL); and ceiling level (TLV-C)
Explain the importance of chemical interactions; dose-response relationship; local and systemic effects; acute, subacute, and chronic exposure; and ingestion, absorption, inhalation in the risk assessment process
Explain half-life, time, distance, and shielding in reference to radiation hazards
Demonstrate the analysis procedure for identification of unknown hazardous materials, their physical and chemical properties, and the likely behavior of the hazardous substance and its container, vessel, or vehicle (HMS)
Compare laboratory and field sample analysis against regulatory limits
Identify considerations associated with the placement, location, and set up of a decontamination site
Identify which activities are required in terminating the emergency phase of a hazardous materials incident
Describe the preparation of a required report with supporting documentation
Describe the process for implementing the Incident Command System for hazardous materials emergencies

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.14: Perform site evaluation

Competency Builders:
Activate site assessment plan
Notify appropriate authorities
Check for immediate dangers to life and health
Determine site topography and accessibility
Determine wind direction
Implement appropriate site health and safety plan
Describe the emergency-response program
Establish boundaries
Restrict site access
Orient zones
Determine needs for PPE
Record findings
Report findings to appropriate authorities
Control site
Monitor site and personnel
Close site

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA	R	P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.15: Retrieve and evaluate hazardous materials and hazardous waste sample data

Competency Builders:

Interpret prints, charts, curves, graphs, maps, plans, and spreadsheets from plotted and tabulated data

Tabulate data using calculators, computers, databases, graphics, and/or spreadsheets

Perform mathematical calculations

Compare appropriate laboratory and/or field sample analyses against regulatory limits

BIL: Essential – PC, ESA, HS, HM
Recommended – ECA

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 28.16: Respond to mock hazardous materials emergency situations

Competency Builders:

Maintain certification in first aid and CPR
Describe the elements of a spill control program
Follow a written contingency plan
Use proper chain of command
Ensure that adequate spill-control equipment and supplies are available
Contact appropriate hazardous materials public and private resources (HMS)
Implement an emergency-response program consistent with local emergency response plan, and the organization's standard operating procedures (HMS)
Select the appropriate strategy for approaching a release site and continuing or stopping the release (HMS)
Implement an Incident Command System for a hazardous materials emergency
Demonstrate competency in first aid, CPR and emergency response
Identify considerations associated with the placement, location, and set up of a decontamination site
Implement decon
Organize and direct the use of multiple teams of hazardous materials technicians in a Command System (ICS) (HMS)
Identify which activities are required in terminating the emergency phase of a hazardous materials incident
Prepare the required report with supporting documentation for a hazardous waste Emergency
Follow media protocol

BIL: Essential – ESA, HM
Recommended – PC, HS, ECA

EDU:	12	AD
PC		I
ESA	R	P
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.17: Describe use of equipment related to hazardous materials and hazardous-waste operations

Competency Builders:
Explain appropriate equipment-decontamination procedures
Identify appropriate operations and maintenance procedures, plans, and manuals
Identify skill and certification requirements
Describe proper use of drum crushers, hand tools, heavy equipment, monitoring and sampling equipment, instrumentation, motorized lifting devices, power tools, pumps, valves, meters, vehicles
Employ communication systems, eyewashes, safety showers, fire extinguishers, and first aid

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.18: Prepare hazardous-materials for transportation and storage in accordance with regulations

Competency Builders:

Prepare documentation related to the shipment of hazardous materials and hazardous wastes

Identify incompatible combinations of chemicals that could result in dangerous situations

Describe safe and healthful procedures for packaging, loading, documenting, and shipping of hazardous materials and hazardous wastes

Inspect hazardous-waste storage areas for compliance with appropriate rules and regulations following a checklist

Segregate and store incompatible hazardous materials and hazardous wastes

Employing a hazard category list

BIL: Essential – HM
Recommended – PC, ESA, HS, ECA

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	R
HM	I	P
WEM		
FWM		
GIS		

Competency 28.19: Demonstrate ability to operate treatment and disposal systems for hazardous-materials and hazardous-waste

Competency Builders:

Record and maintain documentation of operations activities
Contribute to the development and revision of plans and reports
Identify appropriate drums and containers
Document activities of hazardous-waste treatment and disposal contractors
Recommend improvements in the reduction, reuse, recycling, or disposal of waste streams
Describe the collection and disposal of empty hazardous materials containers
Describe the preparation of accumulated hazardous waste for proper disposal
Describe treatment, removal and disposal systems such as: bio-remediation, chemical and physical, deep-well injection, incineration, vitrification, and volatile organic compounds
Describe hazards associated with abatement of materials such as: asbestos, fiberglass, and lead
Describe hazards associated with treatment, removal, and disposal systems and operations
Demonstrate decontamination programs including personnel, equipment and hardware; including level A, B and C ensembles and appropriate decontamination lines

BIL: Essential – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC	I	P
ESA		P
HS	I	P
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.20: Maintain required documents for hazardous-materials and hazardous-waste management activities

Competency Builders:

Demonstrate manifest procedures

Maintain documentation of chain of custody, equipment calibration and maintenance, exception reports, field notebooks, incident documentation, laboratory data, manifests, MSDS, purchase orders, shipping documents, and vendor invoices

Maintain compliance reports

Ensure current MSDS are available in the workplace

Maintain auditable record-keeping systems

Maintain a hazardous-materials inventory

Maintain a hazardous-waste inventory

Maintain an inventory of empty and full containers

BIL: Essential – ECA, HM
Recommended – PC, ESA, HS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA	I	P
HM	I	P
WEM		
FWM		
GIS		

Competency 28.21: Audit regulatory compliance

Competency Builders:
Describe Phase I and Phase II audits
Describe closure reports
Describe the penalties for noncompliance
Follow organization's policies and procedures
Create master file (e.g., data base for record management)
Create/follow audit schedule
Audit records
Interview personnel
Inventory materials and equipment
Assess environmental factors and conditions (e.g., on-site visits)
Write contamination assessment report
Propose corrective action
Verify follow-up activities
Maintain confidentiality
Control dissemination of report finds
Critique the audit process

BIL.: Recommended – PC, ESA, HS, ECA, HM

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 28.22: Contract for services

Competency Builders:
Define scope of work/needs
Write or review specifications
Consult with legal staff
Consult with purchasing department
Provide cost justifications
Research qualified contractors/vendors for services and products
Conduct on-site visits
Select contractor
Secure and award bid
Obtain permits
Train contractors
Evaluate and verify vendor's performance

BIL: Essential – ECA, HM
Recommended – PC, ESA, HS

EDU:	12	AD
PC		I
ESA		I
HS		I
ECA		P
HM		P
WEM		
FWM		
GIS		

Competency 28.23: Conduct preplanning activities

Competency Builders:
Explain need for preplanning
Identify type of preplanning needed
Identify agency involvement
Identify contamination zones
Preplan for hurricanes, tornadoes, floods, fires, nuclear accidents, and earthquakes,
Describe preplanned deployment
Write a contingency plan

Unit 29: Wetlands Management

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 29.1: Identify properties of wetland

Competency Builders:

Explain differences between uplands, wetlands and open bodies of water
Identify the conditions necessary for wetlands to exist
Identify sources of water in wetlands
Describe wetland formation
Describe key elements used to define wetlands
Describe a wetland
Describe characteristics of hydric soils
Describe physical differences between wetlands and upland soils
Describe characteristics of hydrophytic plants
Describe factors which influence the distribution and extent of wetlands
Differentiate between temporary and permanent wetlands
List factors used by the U. S. Army Corps of Engineers and the Environmental Protection Agency to define an area as a wetland
Compare definition of wetlands used by the U. S. Fish and Wildlife Service and the Natural Resources Conservation Service of the U. S. Department of Agriculture

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA, GIS

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 29.2: Explain wetlands classification

Competency Builders:
List common types of wetlands
Differentiate between coastal and inland wetlands
Describe types of vegetated wetlands
Describe types of non-vegetated wetlands
Explain common characteristics associated with each major type of wetland
Identify qualities that distinguish one type of wetland from another
Distinguish between a wetland type and wetland habitat complex
Explain wetland class, form and type

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 29.3: Explain the function of wetlands

Competency Builders:
Identify reasons wetlands are important
Identify ecological functions of wetlands
Identify the role of wetlands as a pollutant removal mechanism
Describe the use of wetlands as part of a comprehensive waste water treatment program
Describe how wetlands can provide a flood control benefit and help prevent soil erosion
Explain the role of wetlands in preserving water quality
Interpret the role of plants in water purification
Explain the role of wetlands in coastal protection
Describe the function of wetlands in ground water discharge and recharge
Describe the ability of wetland soils to filter pollutants from water
Describe the benefits of wetlands in serving as sediment traps
Explain how wetlands can impact atmospheric equilibrium
Describe the filtering ability of wetland plants
Describe how wetland plants remove pollutants from water
List several factors that contribute to wetlands performance in processing waste
Explain the role of wetlands as habitats for commercially important fish, bird and animal populations
Describe the role of the wetlands in primary biological production
Describe the role of wetlands in agricultural production

BIL: Essential – ESA, WEM, FWM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 29.4: Describe the living components of wetland habitats

Competency Builders:

Identify common animals (mammals, reptiles, amphibians, macro-invertebrates) that live and use wetlands
Describe the habitats of these animals
Identify common wetland plants
Describe how plants and animals have adapted to the environmental conditions present in wetlands
Explain morphological, physiological and reproductive adaptations of plants common to wetlands
Identify animals and plants in a wetland food web and describe their role
Describe interrelationships among wetland organisms
Classify selected wetland plants
List some obligate wetland plants
List some facultative wetland plants
Describe the common characteristics of waterfowl family
Explain the role played by wetlands in waterfowl production
Identify fish species of the wetlands

BIL: Essential – ESA, WEM, FWM
Recommended – PC

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA		
HM		
WEM		P
FWM		P
GIS		

Competency 29.5: Assist in wetland delineation

Competency Builders:
Explain wetland delineation
Identify steps used in offsite determination of wetlands
Determine circumstances where offsite method is most useful
Explain use of National Wetlands Inventory (NWI) maps in wetland determination
Explain use of SCS soil survey maps and county hydric soil lists in wetland determination
Explain aerial photos in offsite determination
Delineate offsite wetland
Contrast offsite and onsite methods of wetland delineation
List equipment and materials needed in routine methods of onsite determination
Identify dominant vegetation by strata
Explain measures of plant species dominance
Determine plant species dominance for a particular stratum
Explain criteria used to determine presence of hydrophytic vegetation
Analyze vegetation
Explain hydrophytes
Record indications of wetland hydrology
Record indications of hydric soil
Determine when soil is hydric
Explain routine onsite determination for small areas
Explain routine onsite determination for large areas
Explain transects in onsite determination of large areas
Explain comprehensive method of onsite determination
Delineate onsite wetland
Explain problems in delineating wetlands in drumlins, seasonal wetlands, prairie potholes and vegetated flats

BIL: Essential – ESA, WEM
Recommended – PC, FWM, GIS

EDU:	**12**	**AD**
PC	I	R
ESA	I	P
HS		
ECA		
HM		
WEM	I	P
FWM	I	R
GIS		I

Competency 29.6: Explain impact of an increasing human population on wetlands

Competency Builders:
Explain the historic decline of wetlands
Explain factors that can cause wetland destruction
Explain nutrient overloading
Describe how nitrogen and phosphorus get into a wetland
Explain the effects of oil spills, acid rain and human wastes on wetlands
Describe how wetlands can be harmed by pollution
Explain the use of bio-monitoring to determine pollution
Describe how an overload of pollutants can affect the filtering ability of plants
Explain the potential impact of dams and levees on a wetland
Identify ways land alteration affects wetlands
Explain effects of alteration on wetland hydrology
Explain effects of alteration on wetland soils
Explain effects of alteration on wetland vegetation

BIL: Essential – WEM
Recommended – PC, ESA, ECA, FWM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	R
GIS		

Competency 29.7: Explain government's role in wetland restoration and conservation

Competency Builders:

Distinguish the role played by federal and state agencies in wetland restoration and conservation
Explain Section 401 of the Clean Water Act and the agencies responsible for compliance oversight
Explain Sections 9 and 10 of the Rivers and Harbors Act and the agency responsible for compliance oversight
Explain Section 404 of the Clean Water Act and oversight agencies involved
Describe the National Environmental Policy Act (NEPA)
Explain the Coastal Management Act and identify the oversight agency
Explain how flood plain management programs have potential impact on wetlands
Explain the North American Waterfowl Management Plan
Explain "swampbuster" provisions in Food Security Act
Identify problems in current wetland regulation
Compare economic, social and environmental tradeoffs in various wetland conservation
Explain the "takings" issue
Describe the pros and cons of a "no net loss" policy in wetlands management

BIL: Essential – WEM, GIS
Recommended – PC, ESA, ECA, FWM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		P
FWM		I
GIS		P

Competency 29.8: Identify techniques used in wetland management, enhancement and restoration programs

Competency Builders:
Identify key elements in a wetlands management program
Describe steps involved in an impact assessment program
Explain how Geographic Information Systems (GIS) are used to analyze wetland habitats
Explain how aerial photography, satellite imagery, wetland, and topographic maps are used in wetland management
Determine wetland hydrological disturbance
Determine wetland soil disturbance
Determine wetland vegetation disturbance
Explain wetland restoration
Explain hydroperiod restoration
Explain proper wetland topography reestablishment
Describe how changes in watershed may impact restoration
Describe ways to control invasion of undesirable wetland plants
Describe ways to control destructive wildlife
Describe techniques in using wetlands to treat wastewater

BIL: Essential – WEM
Recommended – PC, ESA, ECA, FWM

EDU:	12	AD
PC	I	R
ESA		I
HS		
ECA	I	R
HM		
WEM		P
FWM		I
GIS		

Competency 29.9: Identify principles used in wetland mitigation and restoration

Competency Builders:
Explain wetland mitigation
Explain wetland mitigation banking
Explain factors to consider in determining a site for wetland development
Describe elements used in design of surface-flow wetlands
Describe elements used in design of subsurface flow wetlands
Describe factors used to determine appropriate plant selection
Describe factors used to attract and stock wildlife
Explain various approaches to wetland design, (e.g., rule of thumb, regression-based empirical and rational approaches)
Compare properties of created and natural wetlands

Unit 30: Watershed Management

BIL: Essential – PC, ESA, HS, WEM, FWM
Recommended – ECA, GIS

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	P
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		I

Competency 30.1: Identify properties of watersheds

Competency Builders:

Explain how watersheds are formed
Identify different types of watersheds and the significant characteristics of each
Explain basic watershed processes and their interrelated nature
Explain how watersheds function
Identify the benefits of a healthy watershed
Explain how change occurs in watersheds
Evaluate the effects of natural and human disturbances on watersheds: landslides, floods, forestry, urbanization, and agriculture
Identify the three zones in a watershed (waterbody, riparian, and upland)
Explain water born pathogen movement in a watershed

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 30.2: Explain watershed management

Competency Builders:

Explain terms associated with watershed ecology
Explain contemporary issues in watershed ecology
Identify different types of watershed management
Identify the principles of long-term watershed management
Identify successful watershed management framework
Identify watershed management benefits
Explain the effect of the 1998 Clean Water Initiative on watershed planning
Identify problems and political aspects of watershed management
Explain how watershed analysis and planning can mitigate watershed disturbances
Explain how human activities within a watershed affect it
Explain the purpose of stream stabilization
Explain methods of stream stabilization (e.g., stream mechanics, natural channel geometry, bank paving, stone dikes, bendway weirs, longitudinal peaked toe, willow pole curtain)
Explain stream hydraulics
Explain sediment transport

BIL: Essential – ESA, WEM
Recommended – PC, HS, ECA, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		P
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM		I
GIS		I

Competency 30.3: Delineate watersheds

Competency Builders:
Identify watersheds on topographic maps
Identify watersheds in the field
Determine the true water-parting divide
Explain the consequences of the surface and sub-surface water-parting divides being different
Explain the use of BASINS software to map watersheds
Prepare source maps

BIL: Essential – PC, ESA, WEM
Recommended – HS, ECA, FWM

EDU:	12	AD
PC	I	P
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		P
FWM		I
GIS		

Competency 30.4: Assess source water

Competency Builders:
Identify methods to assess watershed conditions
Identify factors that impact quality of water
Apply segmentation and risk hierarchy concepts to water
Conduct contaminant inventories

BIL: Essential – WEM
Recommended – PC, ESA, HS, ECA, FWM

EDU:	**12**	**AD**
PC	I	R
ESA	I	R
HS	I	R
ECA	I	R
HM		
WEM	I	P
FWM		I
GIS		

Competency 30.5: Identify elements of a watershed management plan

Competency Builders:
Identify boundaries of the watershed
Determine topography of the watershed
Determine soil types within the watershed
Identify land uses with the watershed boundary
Determine the natural resources of the watershed
Identify social trends, particularly economic and employment data, which may affect the watershed
Determine human activities within the watershed
Identify animals and vegetation in the watershed
Assess risks
Identify stakeholders
Identify environmental objectives
Prioritize issues

Unit 31: Wildlife Ecology

BIL: Essential – ESA, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	I	R
HM		
WEM		
FWM	I	P
GIS		

Competency 31.1: Identify representative animal species

Competency Builders:
Identify representative mammals and their life histories
Identify representative birds and their life histories
Identify representative reptiles and their life histories
Identify representative amphibians and their life histories
Identify representative invertebrates and their life histories
Identify representative fish and their life histories

BIL: Essential – ESA, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	I	
HM		
WEM		
FWM	I	P
GIS		

Competency 31.2: Identify representative amphibians, reptiles, birds, invertebrates, fish, and mammals typical of Ohio

Competency Builders:
Determine the order, family and other appropriate taxonomic categories
Describe differentiating characteristics of the taxonomic groups
Identify examples of Ohio species in each taxonomic group
Identify animals (field and laboratory)
Identify animals from laboratory specimens and field observations

BIL: Essential – ESA, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	P	R
HS		
ECA	I	
HM		
WEM		
FWM	I	P
GIS		

Competency 31.3: Explain animal biology

Competency Builders:

Describe the basic anatomy of amphibians, reptiles, birds, invertebrates, fish, and mammals

Describe the major systems of amphibians, reptiles, birds, invertebrates, fish, and mammals with major emphasis on the digestive and reproductive systems

Describe the nutritional requirements of amphibians, reptiles, birds, invertebrates, fish, and mammals

Explain the role of genetics in the biology of amphibians, reptiles, birds, invertebrates, fish, and mammals

Unit 32: Wildlife Management

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.1: Identify the major factors that affect the growth and regulation of animal populations

Competency Builders:

Compare ecosystem, population, and biotic community
Explain environmental resistance, environmental support, biotic potential, natality, mortality, immigration, emigration, density dependent, and density independent, etc.
Graph and label growth curves
Diagram and label age structures for populations that are increasing, decreasing, or stable
Diagram three types of survivorship curves
Identify the characteristics of populations with low densities and populations with high densities
List the major types of population regulation mechanisms
Distinguish between R and K selected species
Explain the basic principles of population genetics and natural selection
Explain the Hardy-Weinberg Principle

BIL: Essential – FWM

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	P	R
GIS		

Competency 32.2: Explain interdependency of ecosystem

Competency Builders:
Identify communities
Identify relationship between communities of ecosystem
Identify major plant biomes
Differentiate renewable and nonrenewable resources

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	P	R
GIS		

Competency 32.3: **Analyze current trends in the populations of wildlife species in Ohio**

Competency Builders:
List the current population trends for various species in Ohio
Explain the reasons for stable, increasing, or decreasing populations
Identify potential problems

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.4: Control pests that affect wildlife

Competency Builders:

Identify the major external parasites that affect birds and mammals
Identify the major internal parasites that affect birds and mammals
Identify the major vertebrate pest species that affect man and wildlife
Identify appropriate control measures for both invertebrate and vertebrate pest species
Distinguish control measures for invertebrate and vertebrate pest species

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.5: Perform population estimates, food habits analyses, aging and sexing, and necropsy exams

Competency Builders:

Identify types of population density surveys
Identify the measurements made on wildlife species that are used to assess the condition of the wildlife population
Calculate sex ratios, average measurement data on antler beam, and number of points
Set up and run NACSM and grid trap lines for mark-recapture and removal studies
Calculate or determine population size estimates using the Lincoln-Peterson Index plus selected modifications and several removal techniques
Perform food habits analyses on both herbivores and carnivores
Identify the dentition of deer
Explain how replacement of deciduous teeth and wear of teeth serve as age indicators
Identify the major external sexing criteria for bird and mammal species
Identify the major internal organs of birds and mammals
Dissect birds and mammals

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.6: Immobilize wildlife

Competency Builders:

Employ safety procedures when handling and firing a cap-chur gun and related equipment

Hit a target when firing a cap-chur gun on the range

List the major drugs used in the immobilization of wildlife

List the integral components of a radiotelemetry system used in wildlife management

Operate a wildlife materials radiotelemetry unit in the tracking and locating of a collared animal

BIL: Essential - FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.7: Trap animals

Competency Builders:
Identify reasons for trapping
Identify basic types of traps
Identify common animals that are trapped
Identify basic sets of each species trapped
Identify other equipment needed in trapping
Maintain trapline
Maintain records

BIL: Essential - FWM

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.8: Apply animal control techniques

Competency Builders:
Operate restraining mechanisms
Tag legs
Identify animal control purposes
Operate small animal carrier, rabbit restrainer, metabolism cage, and shoebox cage

BIL: Essential - FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.9: Control damage from wildlife

Competency Builders:

Identify potential areas of human-animal conflict and methods to minimize their impact
Identify problems caused by wildlife
Select appropriate wildlife control method(s) for the situation
Apply wildlife control method(s)

BIL: Essential – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.10: Explain ecological principles required for habitat evaluation and manipulation

Competency Builders:

Diagram energy flow through food chains and food webs
List examples of organisms which occupy each trophic level
Distinguish between autotrophic and heterotrophic based food webs
Describe both gaseous and sedimentary biogeochemical cycles
Distinguish between primary and secondary succession
List the various serial stages that occur for typical successional patterns in Ohio
List the ecosystem development characteristics for early, intermediate, and late successional stages
Explain the use of bio-monitoring to evaluate habitats
List the physical, chemical, and biological factors that affect microclimate and how they influence the plant and animal communities

BIL: Essential - FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.11: Evaluate habitats

Competency Builders:

Calculate, and interpret visual obscurity measurements using a vegetation density board
Explain the use of 1/660 aerial photographs in making a cover map
Field verify cover maps
Correct cover maps
Collect quantitative vegetation
Analyze quantitative vegetation data
Interpret quantitative vegetation
Explain the use of plant indicators, plant condition, soil type, soil moisture, and nutrient conditions in habitat evaluation
Explain the role of maps (including glacial, geologic, physiographic, topographic, and vegetation) in habitat evaluation
Compare the different methods used for habitat evaluation
Use GIS in habitat evaluation

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

Competency 32.12: Identify endangered species in Ohio

Competency Builders:
Explain the Endangered Species Act and its primary objectives
Explain why species are endangered
Explain the efforts to save endangered species in Ohio

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

Competency 32.13: Identify the habitat requirements for Ohio's major wildlife species and for endangered species

Competency Builders:

List the habitat requirements for species found in early successional stages, such as rabbit, quail, pheasant and dove

List the habitat requirements for species found in intermediate successional stages, such as deer and grouse

List the habitat requirements for species found in late successional stages, such as turkey and squirrel

List the habitat requirements for species found in wetland types of habitat, such as waterfowl

Identify factors which limit selected endangered species

BIL: Essential - FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM	I	P
GIS		

Competency 32.14: Develop a wildlife management plan

Competency Builders:

Identify reasons for wildlife management

Explain wildlife management practices for forest game, farm game, furbearers, waterfowl, nongame species, and endangered species

Identify animals associated with forest game, farm game, furbearers, waterfowl, and nongame species

Identify types of equipment used in wildlife management

Explain advantages and disadvantages of introduction of wildlife species to new habitats

Explain the importance of healthy wildlife population to local economy

Determine what species of wildlife are to be managed

Establish management practices

Identify management strategies possible in the regulation of ecological succession

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

Competency 32.15: Analyze the role the Ohio Division of Wildlife plays in the total management program of Ohio

Competency Builders:
List the major research units of the ODNR Division of Wildlife
Explain the roles of the major research units of the ODNR Division of Wildlife
Distinguish between the roles of the major research units and the roles played by the various wildlife area crews in Ohio

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

Competency 32.16: Identify wildlife laws used in the regulation of species populations

Competency Builders:

List the types of wildlife laws

Explain how wildlife laws help in the harvesting of animals needed to maintain a viable sustained yield

BIL: Essential – FWM
Recommended - ECA

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM	P	R
GIS		

Competency 32.17: Explain regulations

Competency Builders:
Explain boating regulations
Explain fishing regulations
Explain littering regulations
Explain swimming regulations
Explain park regulations
Explain game laws
Explain stream, lake, pond, and groundwater laws
Explain outdoor burning regulations

Unit 33: Fisheries Management

BIL: Essential – ESA, FWM
Recommended – ECA, WEM

EDU:	12	AD
PC		
ESA	I	P
HS		
ECA		I
HM		
WEM		I
FWM	I	P
GIS		

Competency 33.1: Describe the anatomy and taxonomy of fish species

Competency Builders:

Identify the major parts of the external anatomy of fish species, including all fins and other structures used in taxonomic keys
Identify the family level fish species common to Ohio
Identify the species level selected game fish
Identify the major structures in the internal anatomy of fish useful in species identification, reproductive condition, food habits studies, etc.

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 33.2: Identify the major physical, chemical, and biological features of standing water (lentic) and running water (lotic) habitats that affect fish and their distribution

Competency Builders:

Distinguish between lentic and lotic aquatic habitats

Identify the physical factors, such as flow rates, depth, bottom substrate, temperature, etc. affecting the distribution of fish and other aquatic organisms

Identify the chemical factors, such as dissolved oxygen, pH, hardness, alkalinity, etc. in the distribution, reproduction, and growth of fish

Identify the natural assemblages of aquatic organisms that would normally be found in: pools vs. riffles; lentic vs. lotic habitats; polluted vs. clean water habitats; cold vs. warm water habitats; etc.

Describe changes in the physical, chemical, and biological components of aquatic habitats on a seasonal basis, which will affect fish and their distribution

BIL: Essential – ESA, FWM
Recommended – ECA, WEM

EDU:	12	AD
PC		
ESA		P
HS		
ECA		I
HM		
WEM		I
FWM	I	P
GIS		

Competency 33.3: Conduct fish population surveys

Competency Builders:

Distinguish among the different types of nets used to sample fish populations including seines, trammel nets, gill nets, trap (fyke) nets, and hoop nets
Identify the major components of electrofishing gear used for small stream surveys and in boat shocking systems
Conduct seining and electrofishing surveys on river/stream and lake/pond habitats
Survey shoreline
Interpret data obtained from a 24-hour shoreline survey

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	**12**	**AD**
PC		
ESA	I	P
HS		
ECA	I	R
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 33.4: Analyze water quality

Competency Builders:

Obtain water samples from lakes and rivers
Explain use of portable field kit procedures for analyzing dissolved oxygen, pH, hardness, alkalinity, phosphate, conductivity, and temperature
List procedure manuals and books that contain the wet chemistry methods for in-lab analyses
Run pH and dissolved oxygen tests on water samples
Run a static bioassay test using selected aquatic organisms

BIL: Essential – ESA, WEM, FWM
Recommended – ECA

EDU:	12	AD
PC		
ESA		P
HS		
ECA		I
HM		
WEM	I	P
FWM	I	P
GIS		

Competency 33.5: Conduct studies on fish populations and their habitats

Competency Builders:

Explain the basic parameters of fish population dynamics in terms of rate functions and limiting factors

Explain the use of bio-monitoring to evaluate habitats

Sample aquatic organisms used as forage species for fish and/or as pollution indicators

Identify aquatic organisms used as forage species for fish and/or as pollution indicators

Distinguish among the several types of scales

Determine the age of fish

Explain the major techniques used to tag or mark fish

Identify the types of data obtained from mark/recapture studies

Conduct a fish population estimate

Explain the Lincoln/Peterson Mark-Recapture procedure

Set up a water quality study on a river and lake system

Calculate species diversity index values for fish community data

Run an index of biotic integrity on fish community data

Write a life history report for a major fish species

BIL: Recommended – ECA, WEM, FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		I
FWM	I	P
GIS		

Competency 33.6: Manage aquatic vegetation

Competency Builders:
Identify owner or agency objectives of water area
Explain physical, chemical, cultural, and biological vegetative control methods
Evaluate advantages and disadvantages of aquatic vegetation related to recreation
Analyze water quality parameters
Determine surface area to be treated
Determine volume to be treated

BIL: Essential – FWM
Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM	I	P
GIS		

Competency 33.7: Manage fisheries

Competency Builders:
Identify the components and reasons for making a creel survey
List the types of data obtained in a creel survey
List the major reasons for seasons, bag limits, and restrictions for methods of capture of fish in Ohio
List the reasons for stocking or not stocking fish in aquatic systems
Identify fish stocking guidelines
Identify the types of fish hatcheries and the specific warm and cold water species they produce
List the major manipulation techniques that will improve the quality of aquatic habitats for fish
Describe the procedures for culturing fish
Explain the principles of fisheries management as applied to recreational and commercial fisheries
Interpret fisheries management data
Determine appropriate techniques to reach management objectives

Unit 34: Programming Theory

BIL: Recommended – ESA, ECA, GIS

EDU:	12	AD
PC		
ESA		I
HS		
ECA		I
HM		
WEM		
FWM		
GIS		I

Competency 34.1: Explain programming language concepts

Competency Builders:

Explain the concept of physical representation of digitized information (e.g., data, text, image, voice)
Describe the hardware-software connection
Explain the concepts of data and procedural representation
Explain the function and operation of compilers and interpreters
Explain the basic principles for analyzing a programming language
Explain the basics of structured, object-oriented, and event-driven programming
Explain how a programming language can support multitasking and exception-handling
Identify current key programming languages and the environment they are used in (e.g., C, C^{++}, Visual Basic, Java, RPG, COBOL, Assembler)

BIL: Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 34.2: Desribe the stages of program development

Competency Builders:
Identify the use of program design tools
Explain structured/modular programming
Explain the information system (IS) life cycle
Describe the characteristics and uses of batch processing
Describe the characteristics and uses of interactive processing
Describe the characteristics and uses of event-driven, object-oriented processing

BIL: Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 34.3: Compile technical documentation associated with software development

Competency Builders:
Secure needed information
Analyze specifications
Identify constraints
Identify input and output (I/O) requirements
Prepare logic using a program flowchart

Unit 35: Database Management System Basics

BIL: Essential – ESA, GIS
Recommended – PC, ECA, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	R
HM		I
WEM		
FWM		
GIS	I	P

Competency 35.1: Describe Database Management System (DBMS) basics

Competency Builders:
Interpret terminology associated with relational databases
Identify the features, functions, and architecture of a DBMS
Identify the uses of a DBMS in business organizations
Explain the concepts necessary to access organizational databases
Analyze the organization of data in a DBMS

BIL: Essential – ESA, ECA, GIS
Recommended – PC, HM

EDU:	12	AD
PC	I	R
ESA	I	P
HS		
ECA	I	P
HM		I
WEM		
FWM		
GIS	I	P

Competency 35.2: Develop a report from a database

Competency Builders:

Produce formatted reports
Produce single- and multiple-level control break reports and subtotal and final totals
Query a relational database

BIL: Recommended – PC, ECA

EDU:	**12**	**AD**
PC		I
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		

Competency 35.3: Develop database programs

Competency Builders:

Write programs that allow the user to make a menu choice to carry out an appropriate action

Write programs that require statements to be executed multiple times by using structured programming

Write programs that access multiple files

Design an information system within a database environment

Develop a data model for computation

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 35.4: Build DBMS applications

Competency Builders:

Analyze and model organizations using Entity-Relationship and Object technologies
Remove data anomalies through the process of normalization
Create and update a relational database
Query data from an organizational repository
Perform database administration tasks

BIL: Recommended - HM

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 35.5: Monitor a DBMS

Competency Builders:
Coordinate security requirements
Identify desired levels of access and security
Select monitoring tools and procedures
Identify monitoring methodologies
Identify problems
Document problems
Propose solutions that are congruent with application requirements
Implement solutions to problems
Calibrate DBMS configuration parameters for optimum performance

BIL: Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		
FWM		
GIS		

Competency 35.6: Explain computational and logical operations in software

Competency Builders:
Identify programs that use arithmetic operations
Identify programs that use relational operators and compound conditions
Identify programs that use control breaks
Identify programs that use subtotals and final totals

Unit 36: Database Administration

BIL: Recommended – PC, ESA, HS, ECA, HM, FWM, GIS

EDU:	12	AD
PC	I	R
ESA		I
HS	I	R
ECA	I	R
HM	I	R
WEM		
FWM		I
GIS		I

Competency 36.1: **Apply databases to actual situations and business problems**

Competency Builders:
Derive database design from a workflow drawing or other requirement documents
Design a database for a Geographic Information System (GIS)
Identify the relationship between database components
Sort data on multiple fields
Add and remove filters
Create queries with multiple criteria
Create and apply different types of queries
Join tables in a query
Enhance the design of a form
Create needed subforms
Group data in reports
Make a calculation on a report
Imbed data and graphics
Import data and graphics
Link data and graphics

BIL: Recommended – ECA, HM

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		I
HM		I
WEM		
FWM		
GIS		

Competency 36.2: Apply data modeling techniques

Competency Builders:
Interpret terminology associated with data models
Compare/contrast various data models
Analyze data models
Develop a data model to describe an application's data

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.3: Create conceptual data models

Competency Builders:
Analyze model requirements
Identify business entities and the relationships between them
Identify data in an integrated data dictionary
Facilitate user access

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.4: Validate conceptual data models

Competency Builders:
Present conceptual data model to client
Resolve issues with client
Secure client approval for model
Revise model based on client recommendations
Document validation process

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.5: Integrate conceptual data models with enterprise models

Competency Builders:
Modify conceptual data model to ensure consistency with enterprise model (e.g., entity names, relationships, and definitions)
Develop conceptual schema
Secure client approval for modifications in enterprise models

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.6: Reconcile conceptual models with appropriate-level process models

Competency Builders:
Verify consistencies between models
Identify areas of overlap
Verify that data entities in process model have a corresponding entity data model
Document changes or modifications in either model

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.7: Create logical data models

Competency Builders:

Map data model to a relational model
Identify attributes of model entities and relationships between them
Verify that logical model is consistent with conceptual model
Specify integrity constraints

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.8: Evaluate environment/platform for physical data models

Competency Builders:
Research potential computer environments/platforms
Identify platform capabilities and limitations
Select environment/platform based on technical, business, and skill information gathered
Secure approval of target environment/platform

BIL: Recommended – HM

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.9: **Identify backup and recovery requirements for physical models**

Competency Builders:

Establish backup requirements consistent with corporate policy and business needs

Document established backup procedures

Control access to database to maintain security

BIL: Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		I
WEM		
FWM		
GIS		

Competency 36.10: Identify physical database characteristics

Competency Builders:
Identify name, type, and length of attributes
Employ table and file names that conform to naming conventions
Group/assign tables to disk files
Index files for performance and integrity
Verify that data types are consistent between attributes
Employ normalization and modeling as cross-checking techniques

Unit 37: Geographic Information Systems (GIS)

BIL: Essential – PC, ESA, WEM, FWM, GIS
Recommended – ECA, HM

EDU:	**12**	**AD**
PC	I	P
ESA	P	R
HS		
ECA	I	R
HM		I
WEM	I	P
FWM	I	P
GIS	P	R

Competency 37.1: Explain GIS Basics

Competency Builders:

Explain what a Geographic Information Systems (GIS) is
Identify basic terms associated with geographic information
Identify the advantages of digital maps over paper maps
Explain why geographic information systems are important
Identify some primary uses of GIS
Identify the steps of a GIS project
Explain how GIS helps define and solve geographic questions
Describe primary environmental applications

BIL: Essential – GIS
Recommended - ECA

EDU:	12	AD
PC		
ESA		
HS		
ECA	I	
HM		
WEM		
FWM		
GIS	I	P

Competency 37.2: Explain the basic principles of remote sensing

Competency Builders:
Explain remote sensing
Explain electromagnetic energy
List measurements of electromagnetic waves
Explain how frequency and wavelength are related
Explain why the relationship between photon energy levels and wave energy levels is important to remote sensing
Explain Planck's Law and its manipulation
Explain the various types of scattering which occur when electromagnetic energy passes through the atmosphere
Explain absorption

BIL: Essential – GIS
Recommended – ECA, HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM	I	R
WEM		
FWM		
GIS	I	P

Competency 37.3: Explain the basic principles of aerial photography

Competency Builders:
Identify various camera types
Identify various film types
Explain basic photographic terms
Explain photographic resolution
Explain forward motion compensation
Identify characteristics of CIR film
Explain the use of filters
Explain photographic scale
Explain the geometry of aerial photography
Explain parallax displacement
Explain stereoscopic photography

BIL: Essential – GIS
Recommended – ECA, HM, WEM, FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM	I	R
WEM		I
FWM		I
GIS	I	P

Competency 37.4: Interpret aerial photographs

Competency Builders:
Explain the role of a photo interpreter
Explain how aerial photographs differ from regular photographs
Identify the image elements used in interpretation
Identify the steps in interpretation
Explain interpretation strategies
Explain photogrammetry
Explain relief displacement
Arrange photos for stereo viewing
Determine non-distorted coordinates, horizontal ground distance and angles from measurements on a single vertical photo
Calculate object height from relief displacement
Calculate heights from image parallax measurements
Explain interpretive software

BIL: Recommended – GIS

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

Competency 37.5: Plan the collection of new photos

Competency Builders:
Identify the initial considerations
Write a specification sheet
Provide a flight map

BIL: Essential – GIS

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS	I	P

Competency 37.6: Evaluate accuracy of aerial photographs

Competency Builders:

Explain accuracy, precision, thematic accuracy, cartographic accuracy, and ground truth
Identify general sources of errors
Identify sources of classification errors and factors affecting the errors

BIL: Essential - GIS
Recommended – ECA, WEM, FWM

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA	I	R
HM		
WEM		I
FWM		I
GIS	P	R

Competency 37.7: Explain map projections

Competency Builders:

Explain map projection
List the three general classifications of map projections
Explain the properties of an ideal map (i.e., conformality, equivalence, equidistance, and true direction)
Describe the construction, major property and primary use of various map projections
Explain datum as related to map projections

BIL: Essential - GIS

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		P

Competency 37.8: Describe data structures

Competency Builders:

Describe the three file types (i.e., simple list, sequential, indexed)
Describe the three types of database file structures (i.e., hierarchical, network, relational)
Compare vector and raster data structures
Describe methods of storing raster data
Describe methods of storing vector data
Describe polygon data structures
Describe a polygon network structure

BIL: Essential – GIS
Recommended – HM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM	I	R
WEM		
FWM		
GIS		P

Competency 37.9: Explain digital elevation methods (DEM)

Competency Builders:
Explain DEMs
List the important uses of DEMs
List methods of representing DEMs
Explain interpolation techniques
Describe products derived from DEMs

BIL: Recommended – GIS

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

Competency 37.10: Explain spatial interpolation

Competency Builders:
Explain spatial interpolation
Explain tessellation
Explain planar ordinary Voronoi diagram
Explain ordinary Voronoi polygons
Explain Delaunay triangulation
Explain polygonal methods of interpolation
Explain triangular methods of interpolation
Explain contour generation and 3-D surface plotting
Explain landscape metrics

BIL: Recommended – GIS

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

Competency 37.11: Explain two-dimensional functional spatial analyses

Competency Builders:
Explain area/perimeter/distance calculations
Explain vector-to-raster conversion
Explain raster-to-vector conversion
Explain overlays
Explain Thiessen polygons
Explain querying/theming
Explain corridor analysis
Explain proximity analysis
Explain network analysis
Explain planning rings

BIL: Recommended – GIS

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS		I

Competency 37.12: Explain three-dimensional functional spatial analyses

Competency Builders:
Explain contour lines
Explain how a DEM is created
Explain slope and aspect derivations
Explain orthographic/perspective views
Explain draping
Explain threshold tables
Explain surface filtering
Explain interviewability
Explain surface modeling

BIL: Essential – GIS

EDU:	**12**	**AD**
PC		
ESA		
HS		
ECA		
HM		
WEM		
FWM		
GIS	I	P

Competency 37.13: Explain ranging methods

Competency Builders:
Explain standard deviation
Explain equal interval
Explain natural breaks

BIL: Essential – ESA, GIS
Recommended – ECA, HM, WEM

EDU:	12	AD
PC		
ESA	I	P
HS		
ECA	I	R
HM		I
WEM		I
FWM		
GIS	I	P

Competency 37.14: Identify sources of possible error in GIS

Competency Builders:

Explain accuracy, precision, data quality, and error
Explain the importance of error, accuracy and precision
Identify obvious sources of error (e.g., age of data, areal coverage, map scale, density of observations, relevance, format, accessibility, cost of new vs old data)
Identify errors due to natural variation or from original measurements (e.g., positional accuracy, accuracy of content, sources of variation in data)
Identify errors arising through processing (e.g., numerical errors, errors in topological analysis, classification and generalization problems, digitizing and geocoding)
Explain error propagation
Explain cascading of error
Explain the dangers of undocumented data
Explain how to determine data quality

BIL: Essential – ESA, GIS
Recommended – HM, WEM, FWM

EDU:	12	AD
PC		
ESA	I	P
HS		
ECA		
HM		I
WEM		R
FWM		R
GIS	I	P

Competency 37.15: Determine position on the earth

Competency Builders:

List the major global georeferencing systems
Explain why different coordinate systems have been developed to record location
Explain how the shape of the earth is related to geographic position and to the measurement of distance
Explain how geographic coordinates can be assigned to street address and postal codes using discrete georeferencing
Identify the difficulties and errors that arise in discrete geocoding
Explain what a GPS is
List the major GPS segments as defined by the Department of Defense
Explain how a GPS receiver computes position and time from GPS signals
Explain major sources of GPS errors
Explain the methodological differences between single-user and differential GPS
Explain the practical differences between using GPS for low-precision and high-precision positioning
Determine location and calculate distances using global coordinate systems (latitude-longitude and UTM)

BIL: Recommended – ECA, GIS

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		
WEM		
FWM		
GIS		I

Competency 37.16: Identify legal issues relating to GIS

Competency Builders:
Explain how public access rules affect GIS
Identify liability issues related to accuracy and reliability of GIS information
Identify privacy issues related to GIS data
Explain the use of GIS data as evidence in court cases

BIL: Essential – GIS
Recommended – FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		
HM		
WEM		I
FWM		
GIS	I	P

Competency 37.17: Develop a GIS plan

Competency:
Conduct a needs assessment
Develop a database model
Determine available data
Evaluate GIS hardware and software
Evaluate potential data sources
Develop a detailed database design
Perform pilot study and benchmark tests
Construct the database
Integrate the various components of the GIS
Develop GIS database applications
Maintain the GIS

BIL: Essential – GIS
Recommended – ECA, HM, WEM, FWM

EDU:	12	AD
PC		
ESA		
HS		
ECA		I
HM		I
WEM		I
FWM		I
GIS		P

Competency 37.18: Analyze GIS tools

Competency Builders:
Identify the hardware required for an operational GIS
Describe various GIS software packages and their characteristics
Explain the importance of a DBMS to a GIS
Explain layers and coverages
Explain items to consider when acquiring digital map data
Identify sources of digital map data
Explain media conversion
Explain geographic data conversion
Explain coordinate transformation
Explain tiling and edgematching
Describe the digitizing issues to be considered
Automate map features and attribute data associated with map features
Link map features to a database
Design data tables and layers
Determine answers to spatial questions related to the planning objectives of the GIS application
Organize the output of information based on the analyses
Develop a custom user interface for a GIS application that will simplify and increase user productivity

Unit 38: Communication

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.1: Apply communication skills

Competency Builders:
Guide communication activities using established rules for grammar, spelling, and sentence construction
Follow written and/or oral instructions
Apply creativity in oral and written communications
Proofread documents
Interpret oral, written, and nonverbal communications
Evaluate audience (e.g., specific interests, level of technical knowledge)
Adjust communication style to fit audience (e.g., use of jargon, level of technical details)
Determine means of communications appropriate for given situations (e.g., telephone, meeting, electronic mail, and written communication)
Reinforce intended message using nonverbal communication
Influence listeners' perceptions through precision questioning
Practice active listening skills (e.g., paraphrasing)
Obtain needed information using questioning techniques
Adjust message and/or its delivery based on feedback from listeners (verbal and nonverbal)
Participate in group discussions and meetings
Assess and refine communication skills

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.2: Compose documents

Competency Builders:

Identify the characteristics of different approaches to writing (e.g., direct, indirect, and persuasive)
Identify components of an effective message (e.g., clear, concise, complete, accurate, and courteous)
Evaluate audience
Gather information
Organize information
Develop outline
Draft document
Verify spelling, grammar, and punctuation
Verify accuracy of content

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.3: **Demonstrate sensitivity in communicating with a diverse workforce**

Competency Builders:

Identify factors (e.g., culture, ethnicity, equity, special/exceptional needs) that impact communication

Identify strategies for successful communication with a diverse workforce

Determine communication style appropriate for listener(s)

Bridge communication styles

Establish guidelines for dealing with conflict

BIL: Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS

EDU:	12	AD
PC	P	R
ESA	P	R
HS	P	R
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.4: Deliver oral presentations

Competency Builders:

Prepare presentation and supporting materials (e.g., handouts, transparencies, electronic slide shows)
Practice presentation
Deliver presentation
Obtain feedback

BIL: *Essential – PC, ESA, HS, ECA, HM, WEM, FWM, GIS*

EDU:	**12**	**AD**
PC	I	P
ESA	P	R
HS	I	P
ECA	P	R
HM	P	R
WEM	P	R
FWM	P	R
GIS	P	R

Competency 38.5: Build interpersonal skills with individuals and other team members

Competency Builders:

Analyze the interdependence of empathetic listening, synergy, and consensus building
Define roles within the group decision-making process
Explain group dynamics
Promote teamwork, leadership, and empowerment
Identify strategies for fostering creativity
Analyze the effect of influence, power, and politics on communication
Establish negotiation guidelines

Unit 39: Basic Microbiology

BIL: Essential – ESA, HS, WEM
Recommended – PC, ECA

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	P
ECA	I	R
HM		
WEM		P
FWM		
GIS		

Competency 39.1: Apply microbiological principles and procedures

Competency Builders:
Explain microbial taxonomy and classification
Explain bacterial metabolism, reproduction, cell structures, and their functions
Disinfect and sterilize
Explain classification, composition, and preparation of culture media
Collect, handle and culture specimen
Identify bacteriologic culture techniques necessary for isolation and identification of organisms
Test for antibiotic susceptibility
Identify commonly encountered aerobic bacteria through morphological, physical, and biochemical properties
Prepare Gram stains
Explain collection and handling of specimens for fungal, mycobacterial, and viral specimens
Prepare specimens
Examine specimens
Identify difference between autotropic and heterotropic microbes

BIL: Recommended – PC, ESA, HS

EDU:	**12**	**AD**
PC		I
ESA		I
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 39.2: Explain immunological procedures

Competency Builders:

Explain immune system and normal immune response

Explain physical and chemical properties of immunoglobulins and complement and their reaction in vitro

Explain principles of basic agglutination, flocculation, and precipitation procedures

Perform basic agglutination, flocculation, and precipitation procedures

Explain principles of complement fixation, immunoelectrophoresis and enzyme immunoassay

Explain clinical significance of commonly performed serological tests

BIL: Essential – ESA, HS, WEM
Recommended – PC, ECA, FWM

EDU:	**12**	**AD**
PC		I
ESA	I	P
HS	I	P
ECA		I
HM		
WEM		I
FWM		I
GIS		

Competency 39.3: Describe roles of microorganisms in the environment

Competency Builders:

Categorize common microorganisms (e.g., viruses, bacteria, protozoans, etc.)
Categorize common pathogenic organisms and common microorganisms found in the environment
Describe how microorganisms impact nutrient cycles
Explain microbial decomposition and use of microbes in degrading pollutants

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 39.4: Perform common microbiology procedures

Competency Builders:

Operate microscope, compound microscope, incubator, colony counter, and other basic microbiology and analytical equipment
Identify microorganisms and cells
Quantify microorganisms and cells
Isolate pure cultures
Maintain pure cultures
Analyze fermentation materials
Harvest cells
Transform hosts
Stain cells and/or bacteria
Prepare media
Identify sterile techniques used during handling, sampling, and analytical procedures
Explain Koch's Postulates and their use in determining primary and secondary pathogens

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM

EDU:	12	AD
PC		I
ESA	I	P
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		
GIS		

Competency 39.5: Conduct bioassay tests

Competency Builders:
Explain bioassay [R-WEM]
Identify the purposes of bioassay testing [R-WEM]
Conduct acute/chronic, freshwater/marines NPDES Permit Bioassays for 1, 2, or 3 species
Conduct sediment bioassays
Conduct LC50 and percent survival bioassays
Conduct hazardous waste bioassays
Conduct terrestrial bioassays
Conduct bioaccumulation studies
Conduct biodegradation testing
Conduct whole effluent toxicity testing
Conduct Toxicity Identification Evaluations/Toxicity Reduction Evaluations (TIE/TRE)

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM, FWM

EDU:	**12**	**AD**
PC	I	R
ESA	P	R
HS	I	R
ECA	I	R
HM		
WEM		I
FWM		I
GIS		

Competency 39.6: Contrast prokaryotic and eukaryotic cells

Competency Builders:
List parts of prokaryotic and eukaryotic cells
State function of each cell structure
Distinguish between those parts that are common to both and those that are not always present
Identify the giant polymeric molecule constituting the cell wall
Explain endospore
Identify conditions that favor the formation of endospores
Explain plasmid
Describe nutritional patterns of fungi
Describe fungal identification and cultivation

BIL: Essential – ESA
Recommended – PC, HS, WEM, FWM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA		
HM		
WEM		I
FWM		I
GIS		

Competency 39.7: Identify groups of microorganisms

Competency Builders:
Identify various bacterial organisms by shape
Identify various cell arrangements or groupings
Identify organisms by cell wall types
Identify groups of fungi
Identify groups of algae
Describe types of parasite life cycle

BIL: Essential – ESA
Recommended – PC, HS

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 39.8: Analyze factors affecting microbial growth

Competency Builders:
Correlate how sources of nutrients overlap
Explain microbial nutrition type (carbon)
Compare inorganic and organic nutrients

BIL: Essential – ESA
Recommended – PC, HS

EDU:	12	AD
PC	I	R
ESA	P	R
HS	I	R
ECA		
HM		
WEM		
FWM		
GIS		

Competency 39.9: Describe influence of environmental factors on microbes

Competency Builders:
Explain various temperature requirements
Describe various gas requirements
Describe major types of microbial interaction

BIL: Essential – ESA
Recommended – PC, HS, ECA, WEM, FWM

EDU:	12	AD
PC	I	R
ESA	I	P
HS	I	R
ECA	I	
HM		
WEM		I
FWM		I
GIS		

Competency 39.10: Explain microbial growth

Competency Builders:
Correlate bacterial binary fission with generation time
Describe normal bacteria population growth curve
Indicate methods of enumerating bacteria and measuring bacterial growth
Explain closed bacterial culture
Identify phases of bacterial growth curve

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

NOTICE

Reproduction Basis

☒ This document is covered by a signed "Reproduction Release (Blanket)" form (on file within the ERIC system), encompassing all or classes of documents from its source organization and, therefore, does not require a "Specific Document" Release form.

☐ This document is Federally-funded, or carries its own permission to reproduce, or is otherwise in the public domain and, therefore, may be reproduced by ERIC without a signed Reproduction Release form (either "Specific Document" or "Blanket").

EFF-089 (1/2003)